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An Investigation of Organizational Resilience through Team Operations in Challenging Conditions

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Declaration

This thesis has been composed by me, and, a part of it is my own work; for the rest (where I have been a member of a research group) I made a substantial contribution to the work and this contribution is clearly indicated; and the work has not been submitted for any other degree or professional qualification.

Melike Senturk

May 2018

This thesis is dedicated to my grandma and grandpa…
They are not gone; they walk beside me every day.

Melike

Acknowledgements

It would be impossible for me to finish this work on my own. It would even be impossible to start it in the first place. Hence; I'd like to thank all the people and organisations who helped me achieve this, starting with my dearest supervisor Nick Oliver, who had never withheld his help from me, who mentored me with great wisdom and provided an unlimited source of insight for me, who was always there for me and who gave me the necessary space whenever I needed. I'd also like to thank the other members of the *resilience project team*; my second supervisor Maurizio Tomasella, Kristina Potocnik and Tom Calvard; all helped me so much in their expertise areas. Moreover, I'd like to thank all my PhD fellows for making me motivated to continue when I felt less enthusiastic. I had also received financial support throughout my PhD and for this, I'd like to take this opportunity to thank University of Edinburgh for the Principle's Career Development Scholarship, University of Edinburgh Business School for the Edinburgh Strategic Resilience Initiative Scholarship and to Scientific and Technological Research Council of Turkey (TUBITAK) for Tubitak Doctoral Scholarship. Throughout this journey, I have also come to realise that emotional support is as important as, if not more than, the technical, motivational and financial support. Therefore, I'd finally like to thank all the people who provided that to me: all my dearest Turkish friends who has lived in Edinburgh throughout my studies, for they are so many to be individually mentioned here, my friends and family in Turkey, particularly my lovely in-laws Ceren, Aysel and Zeki, my dearest brother Hakan, my charming parents Kıymet and Baki, and finally, my beloved husband Sinan.

I wouldn't have come this far without you.

With love,

Melike

Abstract

In this study, I investigated the precursors and the outcomes of team resilience. In contrast to many resilience studies, which focus on low-probability, high-impact challenges, I investigated resilience in the face of high-frequency, low-impact challenges that teams can face in their operational environments. I conducted an extensive literature analysis of the field of resilience and on the basis of this constructed a model of team resilience by integrating insights from high reliability organizing, positive organizational scholarship, sensemaking and disaster resilience studies. I then tested and improved this model through an exploratory study of team behaviour in two "Escape Game" settings in which teams of 5 people worked through a series of puzzles under time-constrained and somewhat stressful conditions. Following the exploratory study, I developed the resilience model into an operationalizable format and tested it using seven runs of a simulation study involving 547 individuals in 68 teams. In the simulation, teams had to work both quickly and accurately whilst adapting to the changing conditions of a turbulent, competitive environment. Quantitative and qualitative data were collected on various team attributes, team resilience and team performance. I have used quantitative data as the main source of analysis and qualitative data as a supporting tool. Self-completion questionnaires, objective performance indicators, direct observation and post-simulation team and individual reflections were among the data collection tools that were used to obtain data.

Team resilience shows highly significant associations with a range of objective measures of team performance. In turn, resilience is supported by several team attributes, including collective mental models, effective channels of communication and systems of information gathering and team cohesion. When teams faced challenges outside of their existing action repertoires their ability to improvise also contributed to resilience. Finally, when teams overcame (novel) challenges, this fed back into their accumulated knowledge through collective learning, enriching action repertoires. Together, these features bestow teams with resilience, which, in turn, enables them to overcome disturbances that might otherwise impede operational performance.

In its final form, my resilience model serves as an explanation of the mechanisms of resilience and identifies its antecedents and outcomes. It can inform teams operating in

uncertain, ambiguous and volatile work conditions about the capacities and capabilities they need in order to create and sustain resilience in daily operations.

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1 Introduction

1.1 Background and the significance of the research

> "In an increasingly volatile and uncertain world, one of the greatest assets an organisation can have is the agility to survive unexpected crisis and to find opportunity to thrive in the face of potentially terminal events."
>
> (Stephenson *et al.*, 2010, p. 2)

Many commentators argue that for many organizations the world is getting more challenging and disruptive. Increased volumes of economic shocks, natural disasters, terrorist attacks, political instabilities and other threats are cited as reasons for this (van der Vegt *et al.*, 2015; Annarelli and Nonino, 2016; Linnenluecke, 2017). To respond to these challenges, organizations need to learn to survive and even thrive in the face of these threats and to adapt themselves to changing conditions in their environments. As Gibson and Tarrant put it (2010, p. 6):

> *"Over the last decade, volatility in our natural, economic and social systems appears to be increasing at rates faster than many organisations can cope. Whilst such fast moving events overwhelm many organisations a proportion demonstrate an ability to either manage or bounce back from the adverse effects of system volatility."*

This increased frequency of industrial and natural adversities faced by organizations has stimulated organizational researchers to work on finding ways to make employees, teams and organizations more resilient to these challenging conditions (Shrivastava *et al.*, 1988). The reason is that these challenging conditions, depending on their volume and severity, may cause a loss in customers and revenues (as in the 2008 financial crisis), damage to reputation (as in the Deepwater Horizon oil spill), a decrease in employee morale (as in GM's layoffs between 2008–2010), the termination of functionality (as in Hurricane Katrina) and, worst of all, injuries and fatalities (as in the 9/11 terrorist attacks). Arguably, the urgency of understanding processes of resilience

is increasing, for two reasons. Firstly, adverse conditions around organizations (such as natural disasters, economic crises or depletion of resources) are increasing in volume, severity and unpredictability according to many scholars (Richtnér and Löfsten, 2014; Scholten, Scott and Fynes, 2014; for e.g. Coward, 2015). Secondly, organizations are becoming more vulnerable to adverse conditions because of increased automation and interdependencies (Dalziell and McManus, 2004; Gölgeci and Ponomarov, 2014). Increased collaboration between organizations, which can increase productivity and efficiency, also increases interdependency. Thus, an incident which directly interrupts one organization's operations may also indirectly interrupt the operations of the many other organizations that are connected to the organization directly afflicted. This, in turn, increases the amount of the average cost of downtime per hour from disruptions as demonstrated by the Aberdeen Group (2012).

Despite the increasing prevalence of challenges, organizations may be reluctant to allocate resources to the anticipation, mitigation and elimination of challenges (Ray, Baker and Plowman, 2011). One reason is the greater salience of conventional efficiency and performance pressures (such as growing revenues, outsourcing or decreasing costs) whose outcomes are more tangible and immediate. However, in addition to draining the organizational budgets, these practices may lower organizations' flexibility and increase their interdependence, which, in turn, increases their vulnerability and risk of facing adversities (Mcaslan, 2010, p. 1). For example, Fiksel *et al.* (2015, p. 80) draw attention to the fact that 2011 tsunami in Japan caused great challenges for organizations like General Motors who practice just-in-time and lean production methods, where "managers work closely with a small number of suppliers to keep inventories low". These companies had no slack resources (or contingency suppliers) to supply certain components; and hence, they had to pause their operations.

Adding onto this discussion, Choo (2008, p. 34) states that practitioners are in favour of spending "minimum mental and physical effort" and providing maximum "cost efficiency" in operations. Linnenluecke and Griffiths (2010, p. 500) argue that these practices may be counterproductive in volatile operational conditions. Moreover, Fujimoto and Park (2014) suggest that organizations can both provide for effective crisis response and competitiveness at the same time, if they prioritize resilience along with efficiency and invest in the development of various mental and physical

capabilities. According to Fujimoto and Park (2014), utilizing these capabilities provides recovery from the crisis without increasing the unit costs.

Nonetheless, contrary to conventional organizational concerns, concerns for operational and organizational risks are neglected by practitioners because the outcomes of these concerns may be intangible and very hard to observe or demonstrate (Lee, Vargo and Seville, 2013, p. 30). Activities such as formulating contingency plans or running scenario analyses do not necessarily yield measurable and observable benefits, unless the organization is actually put to the test. Regarding this, Stephenson (2010a, p. 2) points out how hard it is to convince executives to invest in practices without demonstrating tangible and measurable outcomes; and Klein *et al.* (2003, p. 42) suggest that without measurability, resilience cannot serve as a "practical policy or management tool". Thus, robust measures are needed to be able to demonstrate the outcomes of allocating resources towards building resilience, if decision-makers are to be persuaded to invest more heavily in such activities.

Not only may the volume of challenges be increasing, so may be their unpredictability – caused by constant changes in technology, nature, society and economy (Sahebjamnia, Torabi and Mansouri, 2015; Seville, Van Opstal and Vargo, 2015). Thus, even implementing 'planned responses' to anticipated crises, which are expected to facilitate recovery, is found insufficient (Corey and Deitch, 2011, p. 171); and the necessity of successful 'ad hoc responses' to novel situations becomes prominent (Boin and McConnell, 2007). Therefore, even investing in planned responses is not sufficient; therefore, research should guide practitioners with regard to what capacities and capabilities to invest in to be able to formulate ad hoc responses, as well as planned ones.

Recently, investigation of these 'ad hoc responses' has been the main focus of organizational survival researchers and this marked the popularization of the **organizational resilience** concept in the field. As Coward (2015, p. 58) pointed out:

> *"[R]esilience marks a turn from the predictable geopolitical threat of mutually assured destruction to an era of complexity and unpredictability in which subjects must be equipped with the skills to live with uncertainty and respond to crisis."*

Moreover, the widely held assumption that 'all crises and disruptions are merely or mainly bad for organizations' is also challenged by positive organizational scholarship proponents (Sutcliffe and Vogus, 2003). This is supported by many other scholars who challenged the widely held view that people and organizations cannot respond well to large-scale, novel, crisis situations (for e.g. Horne and Orr, 1997; Mallak, 1998a). Positive framings of organizational crises have shaped the way organizational scholars perceive crisis management (van der Vegt *et al.*, 2015, p. 972). Investigations to help organizations *manage crises* have slowly been replaced by investigations of *how organizations can be resilient*. Traditional crisis management perspectives mainly perceive crises as negative situations to be avoided and value the structural elements of organizations that allow them to prevent or absorb these situations (Alesch, Holly, Mittler and Nagy, 2001). As opposed to this, **resilience** emphasizes how adverse situations can present learning opportunities for organizations, drawing attention to the cognitive, emotional and relational dynamics in organizations which can help to overcome adversity.

Two significant streams of work have addressed challenges with a positive framing, acknowledging the benefits and opportunities that might emerge from them. On the one hand, researchers have examined organizations in high-risk industries and have sought to understand the factors behind their survival in these zero-tolerance conditions, where the penalty for even the smallest errors is extremely high. These organizations are called high-reliability organizations (HROs) because, they constantly need to provide for "reliable performance" while operating "hazardous systems" (LaPorte and Consolini, 1991). Since the outcomes of the errors made in these systems are severe, perhaps even terminal, these organizations need to demonstrate resilience to survive in these conditions. Therefore HRO researchers focused their studies on understanding how organizations operating in these conditions are able to continue to functional and on the factors that facilitate this ability (Weick, Sutcliffe and Obstfeld, 2008). Examples of this work are the studies investigating the reliable performances of nuclear power plants (e.g. Carvalho *et al.*, 2008; Gomes *et al.*, 2014), military organizations (Roberts, Stout and Halpern, 1994), aircraft carriers (Weick and Roberts, 1993) and other organizations operating in high-risk industries.

On the other hand, other researchers have investigated organizations in 'normal' risk conditions that experience unexpected crises in the form of natural disasters, industrial shocks, political, technological or economic breakdowns, etc. They have sought to

understand the difference between organizations that can survive crises and those that cannot; and they have tried to determine the factors behind crisis survival. In these studies, researchers have paid particular attention to understanding the capacity for ad-hoc response formulation, because solely relying on planned responses is ineffective when dealing with unexpected events (Kendra and Wachtendorf, 2003b). The most abundant work in this stream is post-hoc examination of organizations facing such unexpected crises. Among this work are notable examples such as investigations into organizations that survived the 9/11 attacks (e.g. Freeman, Hirschhorn and Triad, 2003a; Gittell *et al.*, 2006); climate change and major natural disasters (Dahlhamer and Tierney, 1998; e.g. Nishiguchi and Beaudet, 1998; Linnenluecke and Griffiths, 2013; Williams and Shepherd, 2016); and technological and industrial shocks (Meyer, 1982; Meyer, Brooks and Goes, 1990; e.g. Akgün and Keskin, 2014) along with investigations into supply chain resilience to unexpected disruptions (Sheffi and Rice Jr., 2005; Kamalahmadi and Parast, 2016).

The existing work on resilience is abundant in proposing various antecedents for resilient responses to challenges (Meyer, 1982; notable examples are: Weick, 1993; Horne and Orr, 1997; Mallak, 1998a; Sutcliffe and Vogus, 2003; Lengnick-Hall and Beck, 2005; Stephenson, 2010b). However, there are prominent gaps in the field: first, there is a lack of a generally accepted model built based on these antecedents, and second, there is little explicit investigation and discussion of the outcomes of resilient (or non-resilient) responses. Therefore, the important questions of 'what precursors lead organizations to achieve resilient responses to challenges?' and 'what are the outcomes of resilience that allow us to recognize its existence?' remain unanswered. As stated by Linnenluecke and Griffiths (2012, p. 938): "While illustrating important points, it is likely that existing theoretical and case insights have not yet uncovered the full range of factors leading to resilience".

Even more crucial than these two issues, much previous work in the field has investigated resilience in extreme settings, where the outcomes of adversity threaten the survival of organizations and individuals. As mentioned above, a great deal of work either investigates organizations in high-risk sectors (e.g. nuclear power plants, fire rescue departments) or organizations that have been through extreme adversity (e.g. floods, hurricanes, terrorist attacks). In the development of the resilience field, the resilience perspective is almost exclusively seen in terms of better response to such extremities. An undesirable consequence of this inclination is that it restricts

conceptualization of, as well as research into, resilience to major and one-off disruptions. Thus, resilience research becomes relevant only to "organizations in which reliability is a more pressing issue than efficiency" (Weick, 1987, p. 112). However, a capacity to demonstrate resilience is also important for organizations dealing with less consequential yet more frequent challenges of the operational volatilities and unexpectedness such as an unexpected big order from a customer, the introduction of an advanced product or service by a competitor or a conflict between the units of an organization.

Conclusively, there is a lack of theoretical and empirical work with regard to resilience in less extreme conditions such as sectoral turbulences, daily work stressors or unexpected operational pressures and events. This is important because these non-extreme adversities are far more frequent and are experienced by larger numbers of organizations; and hence, frameworks that explain resilience to these challenges would be beneficial to a much wider organizational population, compared to the frameworks for extreme adversities. The current study targets this gap; it aims to identify the precursors of resilience and also to understand how resilience is, in turn, beneficial for the organizations in non-extreme but still volatile, stressful and turbulent conditions. However, in order to achieve these aims, a number of other gaps and limitations of the organizational resilience field should also be addressed.

On the one hand, there are fundamental gaps at the theoretical level. Starting from the emergence of the general resilience literature, the term 'resilience' has been defined and conceptualized in very diverse ways by many scholars from different disciplines (Lewis, Donaldson-Feilder and Pangallo, 2011). Thus, there is a growing 'need for a common terminology' regarding the term for a convenient and more productive flow of conversation in the field (Dalziell and McManus, 2004, p. 18). Additionally, scholars also point out the limitations of existing conceptualizations; in the sense that they could not be transmitted to 'an operational, measurable concept of resilience' (Carpenter, Walker, Anderies and Abel, 2001, p. 767). Therefore, existing definitions are considered inconsistent and inadequate by many scholars (Burnard and Bhamra, 2011; Cumming *et al.*, 2005; Duchek, 2014). Targeting this gap, the current study aims to establish an operationalizable conceptualization of resilience.

On the other hand, there are also prominent limitations at the empirical level of the resilience literature. First of all, it is generally impractical to observe organizations

when they are in the grip of a crisis. Opportunities to conduct real-time data collection are very limited, as the chances of capturing data while an organisation is responding to a challenge are low and the presence of observers might not be welcomed. Therefore, most resilience research is post-hoc case study investigation of organizations and the data are based on the testimonials of people experienced the event (Lewis, Donaldson-Feilder and Pangallo, 2011, p. 6), which may create a problem of self-report bias. Secondly, resilience is experienced by various kinds of organizations in different settings; and hence, it is very difficult to obtain generalizable results. Thirdly, most of empirical work in the field has collected data at a single point of time. This method choice is problematic because it cannot reveal the processes and mechanisms of resilience. Moreover, it risks treating resilience as a linear process and falls short in demonstrating the effects of learning from crises.

These limitations suggest that the problems associated with empirical investigations of resilience are largely responsible from the gaps in the resilience literature. As Cumming *et al.* (2005, p. 976) stated it is very difficult to operationalize resilience because of its "abstract" and "multidimensional" nature. Moreover, as Bhamra *et al.* (2011) and Linnenluecke and Griffiths (2010) argued retrospective analysis of resilience is much convenient, and hence, most of the time, case studies are preferred as the empirical investigation method. Lastly, as Lewis *et al.* (2011) pointed out empirical investigations of resilience rely on self-reports and restricted samples and are limited in generalizability. Thus, methodological diversity may be an important step in overcoming the problems and limitations in the field. Novel methodologies are required both for all-round investigations of single research subjects and for comparisons of several similar units with regards to their responses to adversity. In their work where they encourage organizational studies researchers to investigate *resilience*, van der Vegt *et al.* (van der Vegt *et al.*, 2015, pp. 976–7) put this as follows:

> *To study the factors that determine resilience, it may be necessary to measure the relevant characteristics and capabilities of individuals and (parts of) the systems, such as those discussed above, and relate those to individual or system vulnerability and recovery indicators. This requires the tracking of the functioning of individuals and systems over a longer period of time during which one or more disturbances take place. For groups or larger systems, this could be realized in an experimental setting where*

individuals work together on a complex task, and, after some time, one or more interruptions are introduced. Although it is impossible to introduce "real" disasters or crises, one could easily introduce disturbances that can be expected to result from such adverse events (e.g., failure of communication systems, high time pressure, and loss of team members). Individual characteristics of participants can be measured before the experiment, and relationship characteristics, emerging network structures, and participant behaviours can be measured during the experiment. Such experimental designs not only allow researchers to collect data from a large number of systems working on similar tasks with objective performance criteria, but also to manipulate a variety of potentially important determinants of resilience, such as the composition of (parts of) the system, the relationships between individuals and groups, and governance structures used to manage the system.

1.2 Overview of the current research

As Rudolph and Repenning (2002, p. 27) point out, organizations that suffer complex adversities, which include frequent novel disruptions, 'must cultivate a complex set of skills, capabilities that have received little attention in the existing literature'. In line with this view and considering the increasing necessity of organizations to formulate resilient responses to challenges, in the current study, I aim to identify a broad set of collective dynamics that contributes to achieving resilience to challenging conditions. However, in contrast to the majority of the previous studies of the resilience field, I aim to identify the collective dynamics that contribute to the resilience of organizations facing non-extreme challenges of everyday operational conditions as well as organizations facing extreme adversities. Accomplishing this aim is essentially beneficial for organizations to effectively deal with the challenges of the operational environment and maintain desired performance levels. This, in turn, may positively affect the stakeholders of organizations such as owners who earn profits, employees who earn their living by working there, consumers who need the products of these organizations, or suppliers who sell to those organizations. Increased resilience is

particularly important for the members of organizations (i.e. owners and workers) as they may be directly exposed (physically and/or economically) to the impact of challenging conditions in certain cases (e.g. Weick, 1993; Freeman, Hirschhorn and Triad, 2003a; Kendra and Wachtendorf, 2003b; Castillo, 2004).

In designing research to accomplish this aim, I exploit a novel methodology that seeks to address the concerns and suggestions mentioned above, raised by Cumming *et al.* (2005, p. 976), Bhamra *et al.* (2011), Linnenluecke and Griffiths (2010), and van der Vegt *et al.* (2015, pp. 976–7). Previous empirical research considering organizational resilience is mainly restricted to post-hoc analysis of single events and single organizations. This method does not allow researchers to observe and understand the unexpressed mechanisms of how certain factors may contribute to resilience and how, in turn, resilience may contribute to positive organizational outcomes. It also does not provide comparability, which facilitates generalizability. Addressing these, I designed the current study to allow for real-time data collection, comparability, and the utilization of objective measures of performance where possible. In addition to testing the relationships between resilience and its antecedents as well as its outcomes, the study explores the mechanisms that lead to the manifestation of these relationships. In other words, this study aims to demonstrate how certain collective dynamics contribute to resilience and how resilience contributes to the maintenance of desired performance levels.

To best address the issues in the field, I designed a research model that exploited a methodology that is unconventional to the field. It comprises of three steps. The first step was to conduct a thorough literature analysis and to establish a conceptual framework based on this analysis. This framework incorporates the various theories and perspectives of organizational resilience (such as high-reliability organizing, positive organizational scholarship, sensemaking, crisis management and business continuity planning) in order to propose a broad set of factors that contribute to resilience. It proposes an integrated framework to address questions of "what are the precursors that facilitate resilience?" and "what is the outcome of being resilient?" The literature analysis reveals that different sets of skills are proposed by many studies to serve that purpose (for e.g. Meyer, 1982; Weick, 1993; Coutu, 2002; Kendra and Wachtendorf, 2003b; Sutcliffe and Vogus, 2003; Weick, Sutcliffe and Obstfeld, 2008) and this framework provides an integrated picture resulting from this analysis. The

summary of the literature analysis and the resulting tentative research framework is given in chapter 2.

Following this, the second step was to refine this framework using an exploratory study before more rigorous testing. In this exploratory study, I compared the propositions and findings from the literature with the results of my observations of the responses of the teams to the challenges they face. This was fruitful in two ways. First, it demonstrated the mechanisms of how the collective dynamics proposed in my research model (and in previous studies) contributed to the manifestation of resilience. In the light of my observations, I reassessed the relationships I proposed in the tentative framework. Second, it served as a practice for the main study by demonstrating the possible problems and challenges that might be faced. Hence, it also allowed for the reassessment and the improvement of the main study research design. The details of this exploratory study are provided in chapter 3.

The third and final step was rigorous testing and validation of the tentative framework with an empirical study that was conducted with a larger population of teams. This study is part of a bigger research project conducted by five academicians including myself. In a carefully planned simulated setting, teams were subjected to challenging conditions and data collected regarding the manifestation of resilience and its outcomes. The details of the research design and the data is explained in chapter 4. The research framework was tested with the data collected and using quantitative as well as qualitative analysis. The quantitative findings associated with these analyses are illustrated in chapter 5 along with their interpretation. The quantitative analysis is also further supported with rich, descriptive qualitative data from critical incidents that occurred during the simulation. The anecdotes extracted from these incidents are used to articulate and exemplify the data obtained from the quantitative analysis. In addition to this, qualitative findings were also utilized in exploring relationships between the components of the tentative framework as well as other newly discovered relationships. The discussion with regard to this further exploration is provided in chapter 6. Finally, in chapter 7, I discuss the wider theoretical and empirical implications of the research.

1.3 Concluding remarks

Resilience research is growing in significance since there is a worldwide increase in the quantity and severity of the challenges facing organizations. Attention towards organizational resilience is growing along with the concerns of scholars towards changing organizational conditions and their impact on organizations. In this study, I intend to respond to these concerns, particularly by exploring the applicability of the results of resilience research by organizations facing 'everyday' challenges and by advancing understanding of the mechanisms by which resilient responses to these challenges are formulated. I hope that the results of this study will assist practitioners to construct strategic plans for resilience to challenging conditions and to invest in the development of relevant capacities and capabilities. The goal is to help organizations to stay stronger, function better and recover faster in the face of challenging conditions.

2 Literature Analysis

2.1 Introduction

The concept of *resilience* lies at the heart of this study. As I mentioned in the Introduction chapter, the purpose of my study is to establish a model to explain resilience by identifying its precursors and its relationship with performance. With this model, I aim to explain the antecedents of resilience to adversity and unexpected events. In this chapter, I provide background to the *resilience* concept before describing the empirical work carried out to date. This background includes the initial adoption of the term resilience in academia, its use by organizational theorists, models and frameworks that explain the concept, its dimensions, its possible precursors and its relationship to performance.

In the first section, the very first studies that the concept of resilience encountered are disclosed and the connotations of the concept examined. In the second section, discussion is narrowed down to the organizational context and the concept's usage in organization studies is described. This section include the initial theories of resilience developed in this field as well as more recently published work. Moreover, various models and frameworks proposed to explain organizational resilience are introduced in order to show the various interpretations of the resilience concept by organizational researchers.

After providing a broad context with regard to what has been done in the field, I discuss the gaps in the resilience literature, both at theoretical and empirical levels. Then, I lay out my research questions, which aim to address the literature gaps. Here, I also elaborate on how I utilized the previous literature to frame and develop my research questions, particularly to establish my research model. Finally, I disclose the research model that I developed for this study and explain it in detail.

2.2 A brief history of the resilience term

Resilience is defined in the dictionary as "the ability of people or things to feel better quickly after something unpleasant, such as shock, injury, etc." or "the ability of a substance to return to its original shape after it has been bent, stretched or pressed" (Oxford Learner's Dictionaries, 2014). As an academic term, it was initially used in the

nineteenth century in the field of material science. It was regarded, first, as an attribute to describe certain elements, and then, as a measure to compare different kinds of elements (McAslan, 2010, p. 2). Thus, its academic conceptualization reaches back to more than 100 years. However, until Holling's work in 1973 it had not been transferred to any field outside of material science.

As a pioneer in applying the conceptualization of the term *resilience* into another field, Holling (1973) used the concept to convey the idea that possessing the characteristic of *stability* is not enough for ecological systems to survive in volatile environments. To be able to survive in environments with frequent disturbances the characteristic of *resilience*, which provides for rapid adaptation to changes, should be displayed by ecological systems. This application by Holling has been embraced by other scholars from his field as well as scholars from other fields such as psychology, economy, social systems, and management (e.g. Carpenter *et al.*, 2001; Rose, 2004; Linnenluecke and Griffiths, 2010; Burnard and Bhamra, 2011).

Referring to Holling's work, scholars gradually increased their interest in and studies of resilience (Linnenluecke, Griffiths and Winn, 2012, p. 22). For instance, Folke and his colleagues (Folke, 2006; Folke and Rockström, 2009; Folke *et al.*, 2010; Carpenter *et al.*, 2012), who, like Holling, are also from field of ecology, examined the development of the concept of resilience in ecosystems and recommended the concept's application in social-systems research. Folke drew attention to the connotations of the resilience concept in addition to absorbing and adapting to change, such as *developing, learning, re-organizing* and *transforming* (Folke, 2006, pp. 253, 259) and suggested that researchers may benefit from such a perspective on resilience in order to understand social systems experiencing changes and challenges.

In line with Folke's (2006) suggestion, McDaniels *et al.* (2008) and Nelson *et al.* (2007) used the concept of *resilience* to understand how complex systems respond to change and adversity. Nelson *et al.* (2007, p. 400) proposed a three-step system adaptation to change, where the first step is the demonstration of the capacity to absorb the change, the second step is transforming the system and the third step is adaptation. On the other hand, McDaniels *et al.* (2008, p. 311) conceptualized resilience in two dimensions, namely **robustness** and **rapidity**, and identified these two dimensions as indicators of a system's resilience to an external shock (or challenge). They illustrated this conceptualization with the graph in Figure 1.

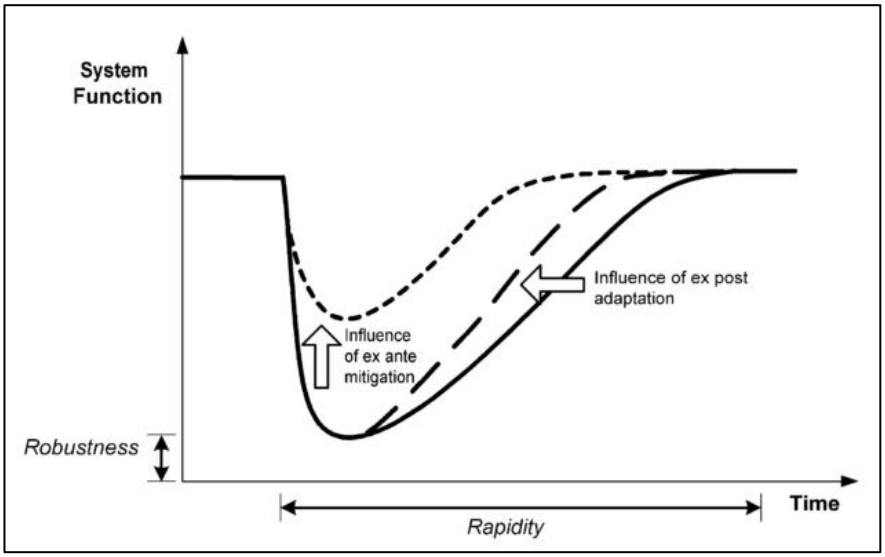

Figure 1. McDaniels et al.'s (2008, p. 312) *conceptualization of resilience*

As seen in the graph, robustness indicates level to which the system functioning is affected by the challenge, i.e. absorption capacity, and rapidity indicates how fast the system returns to the pre-challenge functioning levels, i.e. the adaptation capacity. Absorption capacity may increase the robustness of the system by the system's anticipation of a challenge and adaptation capacity may increase the rapidity of the system through the effectiveness of the system's responses after a challenge is manifested. From this perspective, both prior anticipation and later responses are considered to be manifestations of resilience. Conversely, for some other researchers, resilience emerges only after a challenge has manifested. For instance, Wildavsky (1988, p. 147) defined resilience as "the capacity to cope with unanticipated dangers after they become manifest". Similarly, Weick *et al.* (2008, p. 46) stated that two connotations of resilience are "bouncing back from errors" and "coping with surprises in the moment". This different view focuses on the **unexpectedness** or the **surprise** of challenges and suggests that the increasingly unexpected nature of challenges is one of the stimulants of the emergence of resilience.

Finally and somewhat distinct from the literature mentioned above, the concept of resilience has also been adopted by the psychology/psychiatry field in order to explain certain individuals' tolerance to stressful life events (Sutcliffe and Vogus, 2003, p. 99). Similar to the other conceptualizations of resilience, psychology researchers also identify resilient individuals as being flexible and adaptable in responding to the

negative events in their lives (Wagnild and Young, 1993, p. 166). In addition to this, **resourcefulness** and advanced **problem-solving skills** are included among the resilience characteristics that help individuals recover from adversity (Block and Block, 1980, p. 48; Block and Kremen, 1996, p. 359).

Field	Characterization	Dimensions	Source
Material Science	Attributions of certain elements	Flexibility Absorption	(Mallet, 1856)
Engineering	Approach to provide for the safety of the systems	Adaptability Absorption Robustness Flexibility	(Hollnagel, Woods and Leveson, 2006)
Ecology	Ability of absorbing disturbance and maintaining functions	Absorption Functionality	(Holling, 1973)
Social Systems	Ability of social systems to anticipate and respond challenges	Learning Transformability Re-organizability	(Folke, 2006)
Complex Systems	Ability of complex systems to absorb challenges and quickly provide for normal functioning in the aftermath	Robustness Rapidity	(McDaniels *et al.*, 2008)
	Ability to cope with the challenges and bounce back from them	Coping mechanism Response mechanism	(Weick, Sutcliffe and Obstfeld, 2008)
Psychology	Individuals' ability to bounce back from negative life events	Resourcefulness Adaptability Flexibility	(Block and Block, 1980)

Table 1. Various characterizations of resilience in different fields.

Table 1 summarizes various characterizations associated with resilience, developed by researchers in different fields. It demonstrates that the concept has been adopted and adapted by various fields to explain the ability of entities -which may be materials, systems, individuals, etc. depending on the field - to withstand challenges and to continue normal functioning (or to bounce back to normal levels of functioning quickly) in the aftermath of these challenges. In order to be able to do this, entities demonstrate certain characteristics such as flexibility, adaptability, robustness, resourcefulness, etc. The propositions for such characteristics change slightly from one field to another,

possibly because of the differences among the natures of the entities or due to the nature of the different challenges that these entities face.

2.3 "Resilience" in organizational research

In the face of increased volatility and adversity of organizational environments (Gibson and Tarrant, 2010, p. 6), initially, the **crisis management** literature dominated investigations of organizations facing adverse conditions (Dynes and Aguirre, 1979; for e.g. Mitroff, Shrivastava and Udwadia, 1987; Quarantelli, 1988). This stream of research emphasized the significance of planning (Boin and McConnell, 2007) and precise execution of these plans in adverse conditions. According to the studies in this stream, entities (individual, teams and organizations) would be restricted in using their capabilities while responding to adverse conditions (Staw, Sandelands and Dutton, 1981), because adverse conditions impede communication, information sharing and control mechanisms (Quarantelli, 1988). As a result of these impediments, frontline people were expected to be cognitively overwhelmed and be ineffective in addressing the problems (Weick, 1993). This is why crisis management studies suggested that following a coordinated plan and a strict authority was crucial in responding adversity.

These assumptions of *crisis management* literature were challenged by an additional stream of research that incorporates the elements of the **general resilience literature** and **positive organization scholarship (POS)**. On the one hand, the general resilience literature (elaborated in section 2.2) drew attention to the possibility of facing unexpected challenges, particularly in today's increasingly VUCA (volatile, uncertain, complex and ambiguous) world (Stiehm, 2002, p. 6) and to the possible ineffectiveness of planned responses to overcome these kinds of adversity. On the other hand, POS, which is defined by Cameron and Caza (2004, p. 731) as: "a new movement in organizational science that focuses on the dynamics leading to exceptional individual and organizational performance such as developing human strength, producing resilience and restoration, and fostering vitality", proposed that entities can effectively utilize their action repertoire despite the restrictions caused by the challenges. They also perceive resilience as a capacity that can be developed over time (Luthans and Youssef, 2007, p. 332).

Combining these two perspectives, Sutcliffe and Vogus (2003, p. 95) defined resilience as "the maintenance of positive adjustment under challenging conditions" and proposed, as opposed to the prevalent crisis management literature, that entities may effectively respond to adverse situations, and that resilience is as much to do with the ability to respond as it is to do with the ability to anticipate. They specifically proposed that under enabling conditions (such as effective communication systems or collective efficacy) entities may overcome the restrictions caused by the adversity, which may enhance *action repertoire* of the response and, in turn, enable entity to overcome the challenge (Sutcliffe and Vogus, 2003, p. 107).

Following Sutcliffe and Vogus' (2003) explicit application of the resilience concept to an organization context, *resilience* began to attract researchers in the organization studies field. Because of the continuous increase in volatility, ambiguity and unexpectedness around the organizations, organizational researchers' interests are driven towards investigating the theories and practices that can help organizations overcome these challenges. As a result of this tendency, the body of literature focusing particularly on "organizational resilience" began to develop starting in the 1980s (for e.g. Staw, Sandelands and Dutton, 1981; Meyer, 1982; Tushman and Anderson, 1986; Weick, 1987). A great deal of work in this field is focused on theory development (Bhamra, Dani and Burnard, 2011) as there is still a lack of generally accepted framework to explain resilience (Linnenluecke, 2017, p. 24). However, the number and the variety of the empirical studies are increasing, particularly in the recent years (Linnenluecke, 2017, p. 13).

Organizational researchers have mainly focused on two types of 'challenge experience'. Some of them, particularly during the early development of the field, investigated organizations in high-risk industries, the crises they experienced (for e.g. Bhopal gas leak, Exxon Valdez oil spill, Chernobyl nuclear accident or NASA Challenger explosion) and how they managed (or failed to manage) to overcome them (e.g. LaPorte and Consolini, 1991; Weick and Roberts, 1993; Roberts, Stout and Halpern, 1994). The adversities in these high-risk organizations are generally caused by the escalation of small-scale problems and their dissemination through whole organization because of the interdependencies between system units. This stream of work is concerned with the "organizations in which reliability is a more pressing issue than efficiency" (Weick, 1987, p. 112). These organizations are called High Reliability Organizations (HROs) and the work done in this stream focused on building theories to understand how errors

and anomalies can be identified and contained. This stream of work is elaborated in section 2.3.1.

Other researchers, particularly during the later development of the field, drew attention to the fact that in today's ever more volatile environmental, political and economic conditions, all organizations may face major disasters irrespective of the riskiness of the industry in which they operate (van der Vegt *et al.*, 2015, p. 971). These researchers have observed the challenges posed on organizations by climate extremities (Winn *et al.*, 2011), natural disasters (Bhamra, Dani and Burnard, 2011), global economic volatilities (Gölgeci and Ponomarov, 2014), terrorist attacks such as 9/11 (Gittell *et al.*, 2006) and many other threats in and around organizations; and they wanted to find ways to mitigate and overcome the impact of these disruptive challenges. They stressed the "unexpected" nature of these adverse conditions (van der Vegt *et al.*, 2015, p. 972); as organizations that do not operate in high-risk industries rarely consider the possibility of facing major disruptions. The studies in this stream are discussed in section 2.3.2.

2.3.1 Organizational resilience in high-risk industries

Some organizations face challenges that threaten the very survival of the organizations and their members. **High-Reliability Organizations (HRO)** literature conducted investigations to understand how organizations in these high-risk settings are resilient to these challenges. The term HRO is used to describe organizations that operate complex, high-risk technologies where the scope for error is high and where the consequences of errors are huge - economically, socially and even politically (Weick, Sutcliffe and Obstfeld, 2008, p. 32). These organizations are characterized by *tight-coupling*, which means that the subunits of the organization are tightly interconnected in various known and unknown ways, and hence problems in different subunits may interact with each other in unexpected ways (Rijpma, 1997, p. 15), leading to organizational-level crisis. Reason (2000, p. 769) explains this in his famous "Swiss Cheese Model" by illustrating how holes in organizational defenses, created by the problems in different subunits, may align together and pave way for organizational level damage (Figure 2).

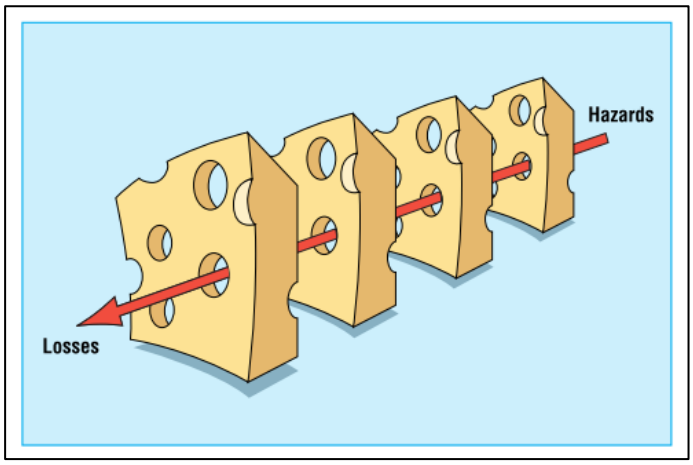

Figure 2. "Swiss Cheese Model" by Reason (2000, p. 769)

In Normal Accident Theory (NAT), Perrow (1984) argued that for organizations in high-risk industries, who have complex systems and tightly-coupled subunits, accidents (organizational level disruptions) are inevitable in their ordinary course of operations. In contradiction to NAT, the HRO theorists assumed that although zero-error operation is nearly impossible (LaPorte and Consolini, 1991, p. 42), these organizations may be designed to constantly seek for providing reliable performance (Weick, Sutcliffe and Obstfeld, 2000, p. 38). In other words, HRO scholars suggest that avoiding terminal crisis is possible by *early detection* of weak signals and small mistakes (Weick, Sutcliffe and Obstfeld, 2008).

Scholars interested in this stream of research examined organizations in various high-risk industries in order to understand how resilience to the risks in these industries are manifested. Among these organizations, we may count nuclear power plants (Gomes *et al.*, 2014), military organizations (Roberts, Stout and Halpern, 1994), aircraft carriers (Weick and Roberts, 1993), firefighters (Barton *et al.*, 2015), air traffic control systems (Weick, Sutcliffe and Obstfeld, 2008), electrical power grids (Christianson *et al.*, 2011) and several others. Studies on these types of organizations demonstrated that successful organizations in high-risk industries follow certain principles and by that they prevent risks from turning into disasters.

In the early studies of organizational reliability, reliability is defined as "…capacities to produce collective products of a given quality repeatedly" by Hannan and Freeman (1984, p. 153) which is achieved by "processes of institutionalization and by creating highly standardized routines" (1984, p. 154). As opposed to that, Weick *et al.* (2008, p.

35) argue that what needs to be stabilized to achieve high reliability are not the routines or procedures but **the cognitive processes** such as "understanding, evidence collection, detection, evaluation, and revising". According to Weick *et al.* (2008, p. 37), stabilization of these cognitive processes establishes **(collective) mindfulness**, which enables HROs to detect and manage unexpected events that cause errors.

To facilitate this, Weick *et al.* (2008, p. 37) propose five principles to provide for *collective mindfulness*, which, according to their theorization, lead to reliable performance while operating in high-risk environments. According to their study, reliable organizations, first, avoid hiding mistakes, openly report and discuss them, and provide opportunities for everyone to learn from them (2008, p. 39). These organizations develop cultures that avoid blaming individuals for mistakes and create platforms to discuss their outcomes and solutions. Second, in these organization, individuals refrain from simplifying the processes and creating cognitive shortcuts to accomplish tasks (2008, p. 41). Whereas such simplifications provide efficiency by saving time and energy, they could lead to overlooking problems and warnings in high-risk environments. Third, in these organizations, every individual is aware about the details of the whole operation and also ready to be fill in for another if needed (2008, p. 43). This can also be interpreted as the members' ability to *see the big picture* and to consult to this big picture when trying to understand the problems and searching for solutions. Fourth, in these organizations, expertise is valued over hierarchy when applying solutions to overcome the adversity (2008, p. 48). These organizations flexibly switch between centralized and decentralized organization structures and, when necessary, decision-making is left with the frontline experts rather than other individuals higher in the hierarchy.

Finally, according to Weick *et al.* (2008, p. 45), HROs constantly expect to face with an unanticipated adversity and be ready to deal with it. They identify this as "commitment to resilience" and suggest that the act of anticipation is never sufficient for organizations in high-risk industries, where the outcomes of adversity may be terminal, and that these organizations cognitively and physically prepared to overcome unexpected challenges. While conceptualizing this principle, Weick *et al.* (2008, p. 46) hold on to Wildavsky's (1988, p. 147) resilience definition of "capacity to cope with unanticipated dangers after they have become manifest, learning to bounce back". According to Weick *et al.* (2008, pp. 46–7) HROs may only provide for this capacity by *being prepared for inevitable surprises*, *paying attention to error prevention and*

containment, *giving formal support for improvisation* and, lastly, *formulating ad hoc response* with the utilization of past experiences.

Using Weick *et al.*'s (2008) insights for high-reliability organizations and their conceptualization of *collective mindfulness*, several studies investigated the sources of resilience in different organizational settings. For instance, Bigley and Roberts (2001) wanted to generalize the application of high-reliability organizing to all organizations with "complex and volatile task environments", particularly to the ones with inflexible structures such as police and fire departments. They examined the mechanisms of "Incident Command System (ICS)", which is a temporary organization system for emergencies, and how it is used to provide flexibility and reliability in this type of high-risk settings. Their study demonstrates the commonalities between the mechanisms of ICS and collective mindfulness such as *deferring to expertise*, *being ready to fill in for another* or *establishing effective communication* to have the cognitive map of the big picture of the operations. Moreover, Christianson *et al.* (2011) demonstrated how ICS provided reliability in electrical power grids and wildland firefighters, and suggested the application of ICS to intensive care units in health care, an high-risk setting in terms of mortality.

2.3.2 Organizational resilience and major crises

With an increase in the volatility and uncertainty of organizational environments, organizations operating in normal risk conditions also started to face unexpected adversity that is hazardous to operations as well as survival. This drove resilience researchers towards examining the organizations which experienced unexpected major disruptions. Particularly, the organizations which were the victims of the world-wide known adverse incidents became the most common research subjects for these researchers. In the aftermath of 2001, these researchers focused on the crises consequential to 9/11 attack (for e.g. Freeman, Hirschhorn and Triad, 2003b; Kendra and Wachtendorf, 2003b; Gittell *et al.*, 2006). Moreover, particularly after 2005, investigations began to target organizations affected by climate extremities and natural disasters (Dahlhamer and Tierney, 1998; Tierney and Bruneau, 2007; for e.g. Linnenluecke and Griffiths, 2010; Winn *et al.*, 2011). Then, in the more recent years, this research spread to other types of major adversities such as economic crises, technological leaps or political instabilities and to various types organizations such as small businesses, large organizations or supply chains (Fujimoto and Park, 2014;

Lampel, Bhalla and Jha, 2014; Pal, Torstensson and Mattila, 2014; Doern, Williams and Vorley, 2016; for e.g. Williams and Shepherd, 2016).

Although resilience researchers examined the effects of various adversities on organizations, there were a handful of significant incidents which particularly boosted attention to the field; the 9/11 attack was one of those significant incidents. This incident proved that even the best-informed entities may face unexpected adversities and even the lowest risk organizations may face threats to their survival. Thus, it was an abundant source of insight for resilience researchers who want to understand what factors are important to effectively overcome the unexpected crises. For example Freeman, Hirschhorn and Triad (Freeman, Hirschhorn and Triad, 2003b) examined the antecedents of the remarkable recovery of an investment bank after the 9/11 attacks. Sandler O'Neill, which was a successful investment bank before the attacks, lost 66 of its employees along with its office and records during the attacks. Unbelievably, they were back in business after just two months and were more profitable than ever in nine months (Freeman, Hirschhorn and Triad, 2003b). The fieldwork, which aimed at revealing the sources of this rapid recovery, discovered that *the motivation of the employees*, *the sympathy from other organizations* and *the ability of company to seize the opportunities* provided for their survival. In another example, Gittel *et al.* (2006) used publicly available data regarding the stock prices, the layoff announcements and the financial and the relational reserves of the airline companies after the attack to search for the antecedents of resilience. They concluded that the *relational reserves* of these companies, when accompanied with the *financial reserves*, provided for the "layoff avoidance" which in turn provided for their resilience (Gittell *et al.*, 2006, p. 325). In this research, several airline companies investigated over a period of time in order to establish causal relationships.

Another attention point for resilience researchers has been the natural extremities and their increased adverse effects on the organizations. For instance, Linnenluecke's and her colleagues' works (Linnenluecke and Griffiths, 2010, 2011; Linnenluecke, Griffiths and Winn, 2012) paid attention to organizational resilience in the context of **disruptive environmental disasters**, aiming to establish a conceptual framework and suggest possible methodologies considering *extreme weather events* and *vigorous climate changes*. Moreover, some other studies also focused on the effects of **natural disasters** on organizations and recovery of organizations in the aftermath of such disasters (e.g. Sanchez, Korbin and Viscarra, 1995; Alesch *et al.*, 2001; Longstaff, 2005; Runyan, 2006).

Pointing out the significance of natural disasters context in organizational literature, Runyan (2006, p. 13) states that: "Some crises are avoidable or may be mitigated, but natural disasters are certainly ones that affect many organizations, and are difficult to predict or prevent.".

Another example of research into natural disasters and their impact on organizations is the work of Bruneau and his colleagues on **seismic resilience** (Bruneau *et al.*, 2003, 2005; Tierney and Bruneau, 2007), which was carried out with the help of Multidisciplinary Center for Earthquake Engineering Research (MCEER). Spanning more than ten years, this stream of work first aimed at identifying the antecedents of community resilience against major earthquake events (Dahlhamer and Tierney, 1998; Bruneau *et al.*, 2003). Later on, direction of the investigation turn to other natural disasters such as hurricanes (Tierney, 2003; Tierney and Bruneau, 2007). As a result of these investigations they established a framework for **community resilience** which they defined as "the ability of social units, e.g., organizations and communities, to mitigate hazards, contain the effects of hazard-related disasters when they occur, and carry out recovery activities in ways that minimize social disruption and mitigate the effects of future hazards." (Bruneau *et al.*, 2005, p. 18). Consequent studies emerging from this stream addressed the *resilience* concept in the context of systems and organizations (McDaniels *et al.*, 2008) and applied the established framework by advancing it further for organizational survivals (Bhamra, Dani and Burnard, 2011; Burnard and Bhamra, 2011). In scope of this framework which addresses the concept in a structural manner resilience characterized under four dimensions, namely **robustness**, **redundancy**, **resourcefulness** and, **rapidity** (Bruneau *et al.*, 2005, p. 19).

In this model, robustness is adopted from the conceptualization of resilience in the field of engineering (Hollnagel, Woods and Leveson, 2006) and complex systems (Bruneau *et al.*, 2005; McDaniels *et al.*, 2008) and indicates an entity's ability to minimize the negative effects of a disruptive event. Moreover, rapidity is also adopted from complex systems (Bruneau *et al.*, 2005; McDaniels *et al.*, 2008) and indicates an entity's ability to quickly overcome the challenge and bounce back to prior operational levels. Furthermore, resourcefulness is about the utilizing the entity capacities and employing the resources to the respond to adversity, which is also mentioned by Wildawsky (1988) as an indicator of resilience. Bruneau *et al.* (2005) established also added redundancy among these dimensions. Redundancy is possessing the additional structures that can replace elements that ceased functioning as a result of disruptions.

Figure 3 illustrates the conceptual framework associated with this model, which is adopted from McDaniels *et al.* (2008) and updated to explain the new framework.

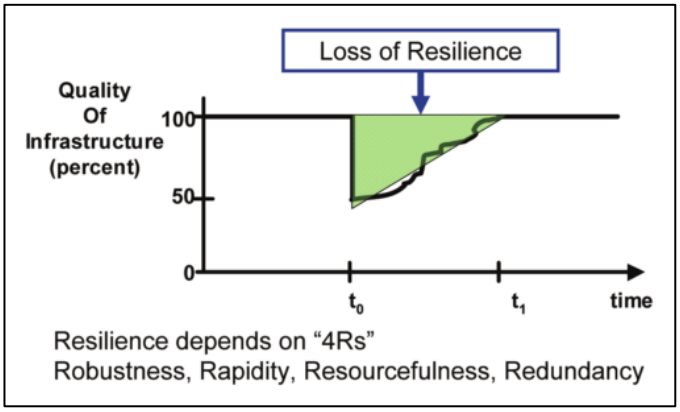

Figure 3. Measure of seismic resilience (Bruneau *et al.*, 2003, p. 737, 2005, p. 19; Tierney and Bruneau, 2007, p. 15)

Subsequent to the investigations of organizational resilience following the 9/11 attack and natural disasters, other work has investigated resilience to major adverse incidents and tried to establish a template to explain resilience in these unexpected extreme adverse conditions. A notable one, Lengnick-Hall and Beck (2005) work, proposed **resilience capacity** as the facilitator of effective response against disruptive surprises. Their framework has three components, namely *cognitive*, *behavioural* and *contextual* resilience, all of which have different subcomponents.

Firstly, cognitive resilience is related to understanding the scope of the crisis situation and developing the plan for an effective response against it (Lengnick-Hall and Beck, 2005, p. 750). **Constructive sensemaking** and **a strong ideological identity** are the subcomponents of this dimension defined by the authors. According to them organizations will correctly analyse crises by *constructive sensemaking*, which means providing descriptions for the novel aspects of the challenges and establishing a collective, mutual understanding of the challenges with the help of these descriptions. Furthermore, with the help of *a strong ideological identity*, which means having an organizational level purpose that unifies members, organizations will be motivated towards collective actions and be able to see the opportunities associated with survival (Lengnick-Hall and Beck, 2005, pp. 750–1). As also mentioned by other resilience scholars (Horne and Orr, 1997; for e.g. Pulley, 1997; Maitlis and Sonenshein, 2010), a shared purpose among the organizational members stimulates them to act collectively to overcome the crises that threatens their organization.

Secondly, *behavioural resilience* refers to the action capabilities of members that will constitute the response to the crisis (Lengnick-Hall and Beck, 2005, p. 751). Subcomponents of behavioural resilience are **functional habits**, which are responses learned as a result of prior experience and knowledge, and **complex and varied action inventory**, which is developed by combining functional habits with improvised solutions. Utilizing appropriate habits is mentioned as a necessary condition by existing resilience literature (Horne and Orr, 1997; Sutcliffe and Vogus, 2003). Resilience researchers also valued diversity and making novel combinations out of existing action repertoires (Weick, 1988, 1993; Kendra and Wachtendorf, 2003a; Sutcliffe and Vogus, 2003; Boin and McConnell, 2007; Vogus and Sutcliffe, 2012). This ability is conceptualized as *improvisation* (Weick, 1993) or *bricolage* (Lengnick-Hall, Beck and Lengnick-Hall, 2011); and described as an ability that is revealed while responding to the challenges (Maynard and Kennedy, 2016, p. 14). Nonetheless, researchers argue that this ability may be developed, first, by encouraging members to formulate novel solutions when existing solutions does not work (Weick and Sutcliffe, 2007); and, second, by expanding the action repertoire, which constitutes the tool to improvise (Sutcliffe and Vogus, 2003).

Thirdly, *contextual resilience,* which is comprised of **deep social capital** and **broad resources network,** maintains the necessary conditions for the utilization of other components (Lengnick-Hall and Beck, 2005, p. 752). This component refers to the relationships with other entities which may provide help in the form of "tangible and intangible resources" while responding to an adversity. This is also conceptualized under different names by other resilience scholars (for e.g. *partnering* (Pulley, 1997), *relationships* (Freeman, Hirschhorn and Triad, 2003a; Cumming *et al.*, 2005) and *social capital* (Danes *et al.*, 2009; Olcott and Oliver, 2014)).

In addition to organizations that experienced significant crises and natural disasters, resilience researchers also investigated **supply chains** as complex and interdependent entities (Kamalahmadi and Parast, 2016, p. 116), for which risks and uncertainties are greater as well as the negative outcomes of disruptions (Sheffi and Rice Jr., 2005, p. 41). Although most supply chains are not comprised of high-risk organizations, the fact that a disruption on the operations of an organization's supplier directly affects the organization itself, or vice versa, puts supply chains under vulnerable entities category (Sheffi, 2001, p. 1). For instance, the fire in 1997, in an Aisin Seiki plant, one of Toyota's suppliers, disrupted production at Toyota, its major customer (Nishiguchi and Beaudet,

1998, p. 50). The vulnerability map for supply chains presented by Sheffi (2007, p. 25) powerfully demonstrates how there are numerous financial, natural, operational and strategic challenges that supply chains (and, as a matter of fact, any organization) face every day.

Addressing this issue, Christopher and Peck (2004, p. 7) suggested four principles to "create the resilient supply chain". First, supply chains needed to be engineered to balance efficiency and redundancy, in order to provide for operational flexibility when faced with an unexpected disturbance (Christopher and Peck, 2004, p. 7). Traditionally, supply chains have been designed to prioritize efficiency in the form of "cost optimization" and "customer satisfaction" (Kamalahmadi and Parast, 2016, p. 122), and a shift from this mindset, in the form of simultaneously prioritizing resilience, is suggested for supply chains to be more resilient to the disturbances (Winston, 2014). Additionally, structural reengineering is also suggested, such as in the form of reducing complexity or increasing dispersion (Blackhurst, Dunn and Craighead, 2011). Second, it is recommended that supply chains establish collaboration and networks among each other to "mitigate risks" and "reduce uncertainties" (Christopher and Peck, 2004, p. 9). According to Kamalahmadi and Parast (2016, p. 124) for effective collaborations among the supply chains *trust* needs to be built and *information sharing* should be encouraged among the participants. Studies by Seville *et al.* (2015), Olcott and Oliver (2014) and Nishiguchi and Beaudet (1998) demonstrated how organizations were able overcome the negative effects of disturbances with the help of strong networks, in the form of *loyal customers supporting the organization during and after the disruption*; *thoughtful competitors helping to overcome the challenge and continuation of operations by providing staff and space*; and *devoted employees motivated to bring the organization back into action quickly*. Third, supply chains needed to be *agile* in the form of "respond[ing] rapidly to the unpredictable [events]" (Christopher and Peck, 2004, p. 10). To provide for agility, supply chains needed to be *visible* in the form of "timely messages about events, along with the planned and actual dates/times of these events" available to all the subunits of the supply chain (Francis, 2008, p. 182); and rapid in responding to the required adjustments (Prater, Biehl and Smith, 2001). Finally, *supply chain risk management* should be established as a culture in supply chains for continuous resilience in the long-run (Christopher and Peck, 2004, p. 11). This culture should be adopted and disseminated by the *leaders* of the supply chain and should

encourage *innovation* for a supply chain's adaptation to the changes in its environment (Kamalahmadi and Parast, 2016, p. 126).

All the studies mentioned in this section aimed at identifying the factors that contribute to the resilience of organization to major crises that threaten their survival and that caused by the volatile and unexpected nature of the organizational environments. In general, these studies conducted post-hoc investigations of major crises experienced by organizations, and they examined the capabilities and capacities that helped organizations overcome these crises. A handful of them (Mallak, 1998a; Christopher and Peck, 2004; for e.g. Lengnick-Hall and Beck, 2005) also tried to establish comprehensive frameworks to explain resilience to crises, however, none of these frameworks are generally accepted or widely applied (Linnenluecke, 2017).

2.4 Literature gaps

This literature has prominent theoretical and methodological gaps that prevent the generalizability of the application of theories in much wider organization populations. In this section, these gaps will be discussed.

As I mentioned in the introduction chapter, the most prominent gap in the organizational resilience literature is identified as the lack of a *generally accepted* comprehensive conceptual framework that explains the manifestation of resilience, its precursors and its outcomes (Annarelli and Nonino, 2016, p. 8; Kamalahmadi and Parast, 2016, p. 126; Linnenluecke, 2017, p. 16). Particularly, as demonstrated by the literature review in section 2.3, resilience is almost exclusively investigated in extreme organizational settings (two notable exceptions are studies by Vogus and Welbourne (2003) and by Ray, Baker and Plowman (2011), where they applied the insight from HROs to non-extreme challenging settings; software firms and business schools, respectively). In most studies, organizations are either operating in high-risk industries where errors are very likely and very costly, or faced a major unexpected disturbance, which could have terminal consequences for them. Therefore, the applicability of resilience research only demonstrated for extreme settings (Linnenluecke, 2017, p. 11); and in most cases only for the specific types of extreme settings. This gap is in relation with two important set of problems in the organizational resilience field: the problems

associated with the conceptualization of resilience and the limitations of the methodologies preferred to investigate resilience.

Many resilience researchers drew attention to the inconsistencies in the conceptualizations of *organizational resilience* (Comfort, Boin and Demchak, 2010; Burnard and Bhamra, 2011; Lewis, Donaldson-Feilder and Pangallo, 2011). Because of the variations among the conceptualizations and characterizations of resilience, scholars started to refer to it as an extremely complex concept (Sutcliffe and Vogus, 2003; Bhamra, Dani and Burnard, 2011). Particularly, Sutcliffe and Vogus (2003) asked important questions, revealing the problems associated with the definition of the term *resilience* in general and in organizational context. They questioned whether resilience is a static characteristic or a dynamic process (2003, pp. 95–6); whether it refers to continue functioning during crisis or being able to recover quickly after it (2003, p. 96); and whether it may be improved by organizational learning as a result of prior experiences or not (2003, p. 97). With all these questions in hand they concluded that a successful theorization of *resilience* could not be carried out yet (2003, p. 99). Table 29 provided in Appendix 10.1 gives the result of a literature review I carried out for the conceptualization of resilience, presenting various definitions and characterizations as comprehensive as possible. This table demonstrates the diversity among the various conceptualizations of organizational resilience.

Moreover, an important element of the conceptualization of *resilience* is the nature of the **challenge** experienced by the entity under investigation. While defining resilience, especially in the initial definitions of *resilience,* scholars generally preferred the words like “danger”, “disruption” and “disturbance” (for e.g. Holling, 1973; Wildavsky, 1988; Carpenter *et al.*, 2001; Sheffi, 2005) to refer to challenge. These definitions restricted the utilization of the *resilience* concept to extreme settings, as according to these definitions to be able to use the term *resilience* about overcoming a challenge that challenge had to engender terminal consequences. On the other hand, there are other definitions of resilience, which are relatively newer ones, where challenges are referred as “challenge”, “surprise”, “adversity”, “unexpected event” or even “stressor” (Sutcliffe and Vogus, 2003, p. 95; Ponomarov and Holcomb, 2009, p. 131; Carmeli, Friedman and Tishler, 2012, p. 15; Bowers *et al.*, 2017, p. 2), which suggest that the concept of resilience may be considered in the context of non-extreme adversities, and so resilience research may be generalizable to much wider populations.

In this regard, Williams *et al.* (2017, p. 742) discussed the "severity of adversity" required to call an effective elimination of such adversity as *resilience*. They concluded that resilience is not just "a capacity to deal with rare, devastating events", and "[t]he idea that resilience is more ordinary and required more broadly shows up in the organizational literature". Moreover, Comfort *et al.* (2010, p. 8) also mentioned the ambiguity with regards to the "severity of the disturbance" while defining resilience. They stated that the range could be from "devastating events" to "anything non-normal to operations" and argued that both ends are problematic: whereas the former restrict the positioning of the concept, the latter undermines its significance. Consequently, they used the term "disturbances… that fall outside the range of normal and expected disturbances" to define challenge. The analysis of both studies demonstrates that the challenges that require organizations to be resilient could be faced with a broader range of organizations in various settings than the previous studies concentrated on. Considering this, the dearth of research on resilience in this "more ordinary" settings arises as a significant gap in the literature.

The second set of problems associated with this gap arises from the scarcity of the methodological diversity and the limitations of the preferred methodologies in the field. The organizational resilience field is strongly dominated by post-hoc investigation of single organizations that have experienced a major disruption and this work is generally in the form of **case studies** (Bhamra, Dani and Burnard, 2011, p. 5385; Linnenluecke, 2017, p. 15). I have identified four reasons for this pattern. Firstly, as there is *no unanimously accepted conceptual framework* for organizational resilience (Lewis, Donaldson-Feilder and Pangallo, 2011), organizational resilience researchers are directed towards qualitative studies, which provides rich data and subsequent elaborate analysis (Richtnér and Löfsten, 2014). Case studies are considered one of the best methodological strategies to address these researchers' desire to answer the "what" and "how" questions (for instance, Christianson *et al.*, 2009; Jaaron and Backhouse, 2014). As a notable example, Kendra and Watchendorf (2003a, 2003b) conducted an *inductive* research project that comprised 750 hours of exploratory fieldwork on the September 9/11 event "to identify successes and challenges experienced by those responding to the disaster" (Kendra and Wachtendorf, 2003b, p. 38). In their study, they pointed that (2003b, p. 41): "While defining resilience is clearly challenging, identifying the features of organisations and other social units that make them resilient is even more difficult."

Secondly, to investigate resilience in wider and more quantitative settings, a thorough *operationalization* of resilience is essential; and as Cumming *et al.* (2005, p. 976) stated: "The abstract, multidimensional nature of the concept of resilience makes it difficult to operationalize". This problem makes it extremely difficult for organizational resilience researchers to design research based on quantitative methods (Carpenter *et al.*, 2001; Richtnér and Löfsten, 2014). In order to overcome this problem, certain researchers have tried to operationalize the earlier conceptualizations of organizational resilience. For instance, Somers (2009) conducted an empirical research on 96 municipal public works departments to measure their resilience potential. The questionnaire used in the research was developed by utilizing Mallak's (1998a) six dimensions of organizational resilience. In another example, Akgün and Keskin (2014) used Lengnick-Hall and Beck's (2005) organizational resilience conceptualization to develop a questionnaire that measures organizations' resilience capacity. On the other hand, other researchers in the field have tried to operationalize resilience by defining the concept with measurable terms. For example, Cumming *et al.* (2005, p. 976) defined resilience as: "the ability of the system to maintain its identity in the face of internal change and external shocks and disturbances" and then operationalized *identity* (as the preservation of "key components and relationships") to propose a measure to investigate resilience in larger research settings. Although these study-specific operationalisations facilitated the investigation of resilience by making it measurable, they caused conceptual inconsistency by operationalizing resilience in diverse ways.

Thirdly, organizations, disruptions and environmental settings are so diverse that it is extremely hard, if not impossible, to design investigations with a high number of comparable cases. Lewis, Donaldson-Feilder and Pangallo (2011) demonstrated how diverse organizations going through disruptions may be by identifying several differences regarding size, sector, industry and culture. Moreover, Comfort *et al.* (2001) acknowledged that disruptions range in severity immensely and because of that it is very hard to compare one another. Lastly, even for similar organizations that are going through similar disruptions different environmental settings may change many things. For example, Winn *et al.* (2011) suggested how organizations in politically unstable settings may be more resilient against unexpected political crises compared to organizations operating in politically stable settings. From another perspective, Weick and Sutcliffe (2007) highlighted how in some environmental settings even the smallest errors are unacceptable whereas in others errors are more easily tolerated. This

problem of extensive diversification restrains organizational resilience researchers from designing research with a large number of cases. As a result, empirical studies in the field have focused mainly on either single organizations or single disruptions.

Finally, it may be enormously costly in both time and money to conduct empirical research on a large number of cases in the organizational resilience field since the unit of analysis is generally either an organization or a disruption. If the unit of analysis is organization, then the researcher should examine organizations operating under similar environmental settings and going through the same or similar disruptions in order to systematically compare resilience capacities. Similarly, if the unit of analysis is the disruption, then the researcher should examine disruptions that are comparable in severity in order to compare the relative resilience shown by the affected organizations. Carlson *et al.* (2012) explains how as the size of unit of analysis increases time and budget limitations prevent adequate collection of information. In that regard, resilience researchers inclined towards case studies of single organizations because of identifying large organizations as the unit of analysis.

Elaborate post-hoc case-study investigations of resilience are helpful to understand and explain how resilience was possible; however, only to a degree and only in specific settings. There are three important limitations with this approach. First, this work mainly focused on investigating resilience of a single (generally large) organization that went through a high-impact crisis; and this type of settings are very unique and extreme. Hence, it is not straightforward to apply the findings of these studies to different settings as the work has been very diverse, unattached and non-generalizable (Lewis, Donaldson-Feilder and Pangallo, 2011, p. 6). Linnenluecke (2017, p. 15) summarizes this limitation very clearly:

> *"These studies usually diagnose what happened (or 'how resilient' the organization was) in a certain situation, and seek to derive insights into how future resilience may be improved, based on a generalization from these insights… they do not draw out the context-dependence of their insights, and little is known about the transferability of insights across different contexts."*

Second, in most of these studies, the data is collected at a single point of time, and after the event already taken place. This is problematic in two ways. On the one hand, since data is not collected for the entire duration of challenge-response process, the

mechanisms of resilience might not be revealed. In this case, it is impossible to demonstrate adequate causal connections regarding the nature of the response and the process of the recovery. As a notable exception to this, Alesch *et al.* (2001) analysed 50 firms affected by Northridge earthquake in 1994 over a period of 30 months starting right after the earthquake occurred. This allowed them to assert causal relationships between certain dynamics (such as awareness, confidence and emotional strength) and a resilient response.

On the other hand, even collecting data about a single challenge throughout a time period may be inadequate. Investigations in this manner treat organizational resilience as a linear process (Folke and Rockström, 2009, p. 1), which, in fact, may better be treated as a cycle (Carpenter *et al.*, 2001, p. 766; Scholten, Scott and Fynes, 2014, p. 216). No organization gets over a single challenge and becomes free from adversity thereafter. All organizations are in cycles of disruptive and non-disruptive periods. Thus, an organization which is fairly resilient in one disruptive period may fail to respond effectively in another. What is more, going through one challenge may increase the resilience of the responses against future challenges through a learning effect (Weick, Sutcliffe and Obstfeld, 2008).

Thirdly, the testimonials of individuals who have experienced and dealt with the challenge constituted a significant part of the data in resilience studies; and this creates the possibility of self-report bias. Although self-report bias is a general problem in the organization studies literature (Youssef and Luthans, 2007, p. 793), it may also cause problems that are specific to resilience studies. Fundamentally, people may recall their responses against crises very differently than their actual responses, since in most disruptive situations they are emotionally and psychologically overwhelmed or compromised (Weick, 1976, p. 15; Alesch *et al.*, 2001, p. 42).

2.5 Research Questions

In line with the initial literature analysis conducted in the organizational resilience field, two questions were identified to guide my study:

> *Q_1: What attributes make organizations more resilient to the challenges they face?*

Q_2: What are the antecedents / precursors of resilience?

Although these questions have been asked previously in the growing organizational resilience literature, an answer that satisfies the worldwide community has yet to be provided (Linnenluecke, Griffiths and Winn, 2012, p. 938). Moreover, much of the work in the resilience field has searched for answers to these questions in particular settings, hence the answers they found have only been relevant to a limited population of organizations. Thus, these are still the most fundamental research questions in the field, particularly for organizations that seek to be resilient to the challenges of daily operational conditions.

Further literature investigation also demonstrated the importance of how being resilient benefits organizations. In the context of *high-risk organizations* and *organizations in the midst of a major disruption* being resilient is very much related to survival (continuity) and maintaining of primary functions as stated by the previous research (Stephenson *et al.*, 2010, p. 3; Lampel, Bhalla and Jha, 2014, p. 71; Williams and Shepherd, 2016, p. 2069). However, in the context of *overcoming the challenges of daily operational conditions* the researchers should consider other outcomes as these less severe challenges will not be affecting the survival of an organizations or its basic functions. Thus, a third question is added among the main research questions:

Q_3: What are the outcomes of resilience?

While designing my research, I wanted to bring this question into a more specific and measurable form. I specifically wanted address this question in the context of organizational settings where organizations are not dealing with survival-related problems. In general, resilience is defined as *the ability to absorb adversities and continue to function normally in the face of adversities*. For organizations, 'to function normally' could mean 'to be able to achieve its aims' and 'to be able to continue operations'. If continuity is not a problem, then the main concern for an organization is 'performance' (this reasoning is articulated in section 2.5.2). Expressed in measurable terms, it means 'the ability to provide for normal performance levels'. Hence the research question becomes:

Q4: How resilience is related to operational performance?

Furthermore, if the circumstances were ideal, I would prefer to conduct my research on a large sample of organizations that are going through comparable challenges during

their operations; and I would prefer to collect qualitative and quantitative data that would allow me to compare the responses of organizations to these challenges. This would provide a rich, elaborate explanation of the mechanisms of resilience while at the same time strengthening the generalizability of the results. However, just as all the other resilience researchers, I did not have the necessary time and budget to collect data on a large number of large organizations. This problem forced organizational resilience researchers to conduct their investigations in the form of single-case studies, and as a result of this, resilience research became disintegrated and non-generalizable (Linnenluecke, 2017, p. 15). Several studies in the field reported a need for a caution for the generalizability of their findings (Bigley and Roberts, 2001; for e.g. Wilhelmsen, 2011) and most of them suggested replication in diverse settings (for e.g. West, Patera and Carsten, 2009; Stephens *et al.*, 2013). The lack of comparability lies at the heart of this problem (Alesch *et al.*, 2001; Furniss *et al.*, 2011). To address this issue, I sought to conduct a study with a relative larger sample; however, to be able to conduct the research within the time and budget I have, I preferred to work with small-size research units. Hence, I identified the unit of analysis as team. With this choice, I refined my research questions as:

Q_5: What are the precursors of team resilience?

Q_6: How is team resilience related to team performance?

Conclusively, in this study, I aim to find answers to the questions above and intend these answers to be applicable by a wide population of organizations. While addressing these questions, I utilized deductive reasoning: based on the literature analysis I conducted, I have built a model that addresses my research questions and then, I have tested and improved this model with empirical investigations throughout my research. The following sections elaborates on the literature analysis I utilized to build my research model. In section 2.5.1, I provide the literature background with regards to the precursors of team resilience; and in section 2.5.2, I provide the literature background with regards to the relationship between team resilience and team performance.

2.5.1 Precursors of 'team resilience'

Teams are defined as the units that comprise two or more individuals to accomplish a common purpose (Baker and Salas, 1997; Cohen and Bailey, 1997); hence establishing teams "allows for the completion of tasks that require more than one individual" (Bell,

2007, p. 595) through collective dynamics. Since teams are capable of "complex and difficult tasks" (Salas, Cooke and Rosen, 2008, p. 540), scholarly work on understanding teams and teamwork is extensive and spans more than half a century (Mcgrath, 1991). Detailed reviews of this work may be found within areas such as team classification (Devine, 2002), team composition and diversity (Lau and Murnighan, 1998) team effectiveness (Kozlowski and Ilgen, 2006; Salas *et al.*, 2007), team training (Salas and Cannon-Bowers, 2001; Kozlowski and Ilgen, 2006), team dynamics (Ilgen *et al.*, 2005), team processes (Marks, Mathieu and Zaccaro, 2001), and team performance (Guzzo and Dickson, 1996; Devine and Philips, 2001; Kerr and Tindale, 2004). Although this work provides useful insights into teams working in normal conditions, more focused research is required to understand teams working in challenging conditions (Vessey and Landon, 2017), the area with which my study is concerned. Hence, while investigating the literature on team dynamics in relation to resilience, I focused specifically on work on organizational and team resilience.

Within the context of my study, team resilience is defined as **the ability of a team to overcome the challenges and disruptions it faces and to continue its normal functionality despite these challenges and disruptions** (Sutcliffe and Vogus, 2003; Alliger *et al.*, 2015). These abilities require teams both to be comprised of individuals with distinct capabilities (Sutcliffe and Vogus, 2003, p. 102) and to act as single capable organisms that can demonstrate collective skills (Vidal and Roberts, 2014, p. 19). As I mentioned before, the resilience literature is rich in case studies of organizations (and teams) that have been through major disruptions (Weick, 1993; Nishiguchi and Beaudet, 1998; Freeman, Hirschhorn and Triad, 2003a) and in all these studies, researchers elaborate on these capabilities and skills that were effective in the recovery (or, if there was no recovery, they propose capabilities and skills that would be effective). There are similar propositions and findings with regards to these capabilities and skills in the organizational resilience and team resilience literatures. This may propose that a comprehensive framework that explains resilience of teams may also be used to explain resilience of larger organizations.

To begin with, researchers drew attention to the importance of **collective knowledge of operations, roles and positions** (*collective mental models*) within an entity that is responding to adversity. Considering the roles of members in an entity, many researchers highlight the significance of *specialization* for efficiently maintaining the operations and for effectively responding to the challenges by allocating tasks to the

experts (Vogus and Sutcliffe, 2012; Richtnér and Löfsten, 2014). Nonetheless, researchers also stress the problems specialization may cause with regards to limiting flexibility (Bigley and Roberts, 2001, p. 1281) and reducing slack resources (Winn *et al.*, 2011, p. 169). Therefore, team resilience researchers (as well as the researchers of resilience at the other levels of organization) propose that specialization should be supported by mechanisms that will provide for flexibility. Weick (1993, p. 640) proposed that to provide for flexibility each member should possess the knowledge of every member's roles, tasks and positions. Thus, all members will be able to fill in for another if it becomes necessary. Weick (1993, p. 640) conceptualized this capacity as *virtual role systems* and noted that in addition to fulfilling the requirements of their specific roles in the team, members should be aware of the requirements of other roles in the team as well as the interrelation of all the roles within the team. This awareness becomes an important asset when a role could no longer be fulfilled by the member assigned to it: knowing the requirements of the role, another member may easily replace that member.

Other concepts were also introduced to refer to this capacity such as *collective mind* (Weick and Roberts, 1993), *shared mental models* (Maynard and Kennedy, 2016) or *transactive memory systems* (Bowers *et al.*, 2017). This enhanced knowledge on top of the specific expertise that specialization require is extremely significant when the team faced with adversities. Particularly, adversities may restrain certain members from fulfilling the requirement of their roles or these members might have to cease fulfilling their roles to address the adversity. When that happens, other individuals in teams with shared mental models (or transactive memory systems or virtual role models) may confidently volunteer to fulfil these unfulfilled roles. In addition, when addressing challenges, the *collective mind* capacity provides the collective and mutual understanding of the problem (Weick and Roberts, 1993) as well as the effective coordination of the collective efforts to overcome it (Maynard and Kennedy, 2016, p. 17). Previous literature also demonstrated the importance of maintaining and constantly updating collective mental models in detecting and understanding the challenges (Roberts, Flin and Cleland, 2015, p. 96).

Moreover, as a way for the shared mental models/roles system to function, there should be an **effective communication system** established among the members of the entity. This was proposed by Weick and Roberts (1993) in their "heedful interrelating" concept, where they suggest that in order for a team to establish collective mental

models, it needs to have effective communications systems among the members, where members interact by "noticing, taking care, attending, applying one's mind, concentrating, putting one's heart into something, thinking what one is doing, alertness, interest, intentness, studying, and trying" (Ryle, 1949, p. 136 in Weick and Roberts, 1993). Weick (1993, p. 642) suggests that this idea of the positive effect of well-established team communication systems on resilience is reinforced by "respectful interaction". Using this concept, Weick suggested that team members' minds can only be aligned (which he conceptualized as *virtual role models*) by effectively exchanging the various interpretations of the situation and establishing a comprehensive single interpretation based on these exchanges. This provides for the collective action as a single unit while responding to challenge. Other conceptual work on the precursors of resilience has also proposed positive relationships between effective communication channels and resilience (Horne and Orr, 1997, p. 33; for e.g. Sutcliffe and Vogus, 2003, p. 102) Testing these propositions, various studies have supported this relationship: as examples, one can point out Maynard and Kennedy's (2016) investigation on NASA teams, and Morgan *et al.*'s (2013) study on sports teams. Both of these studies confirmed that effective communication among team members allowed them to execute collective action in response to the adversity they faced.

Most studies conceptualizing or validating the relationship between resilience and effective communication have argued that while intra-team information exchange, conceptualized as *effective communication*, is crucial in aligning collective mental models and collective action, the accurate interpretation and processing of **information gathered from the external environment** is crucial to formulate the right solutions and actions to address the challenges (Sutcliffe and Vogus, 2003, p. 108). Acknowledging this, in the context of resilience to the adversity, scholars proposed establishing *situational awareness* by enabling the flow of information (Sutcliffe and Vogus, 2003, p. 108), by being attentive to external information with regards to the early and weak signals of problems (Weick, Sutcliffe and Obstfeld, 2008, p. 43); by checking information from multiple sources to ensure accuracy (Mallak, 1998a, p. 151; Fruhen *et al.*, 2014, p. 32), and by collectively assembling and interpreting the information to establish a big picture of the situation (McManus *et al.*, 2007, p. 20; Fioratou *et al.*, 2010, p. 88; Alliger *et al.*, 2015, p. 180). Validating this, Edson' (2012) study on a large project team, Meyer's (1982) study on strikes in hospitals and Vidal and Robert's (2014) study on firefighting teams demonstrate the importance of

continuously scanning the environment and being attentive to the weak signals in formulating effective responses by detecting challenges and threats before they escalate.

Regarding this, Weick *et al.* (2008, p. 44) draws attention to the possible negative consequences of gathering too much unnecessary information while trying to maintain the "broad operational awareness". The process of continuous information gathering may be costly in terms of overwhelming the members and overloading the information channels, a problem which may be coupled by the experience of an adversity (Quarantelli, 1988, p. 375). To overcome this problem, resilient entities pay particular attention not to overwhelm members while processing necessary information, and process information selectively not to overload channels. For example, in their empirical study of nuclear power plant operators Furniss *et al.* (2011, p. 8) observed that a team member put a paper clip on the page where problem solving procedures were detailed about the problem experienced in order for information channels not to be overloaded with the remaining information in the problem solving guide. Conclusively, while *comprehensive information gathering* is proposed as an important source of resilience, it is also suggested to paying attention not to overload the information channels with unnecessary information.

Prior knowledge and experience is another capacity frequently proposed as the precursor of resilience. It is conceptualized as *accumulated knowledge* by Sutcliffe and Vogus (2003, p. 101) in the form of "acquiring new skills, mastering new situations and improving competence" and found necessary "for new knowledge to be assimilated and used". Moreover, Horne and Orr (1997, p. 32) called in *competence* and portrayed it as having the necessary skills and applying them effectively. Lastly, McManus *et al.* (2007, p. 34) included it as *information and knowledge* in their framework to denote the effective application of specialized knowledge while responding to the challenges. In their book, Weick and Sutcliffe (2007, p. 99) suggested that resilient organizations are "actively concerned with developing people's skills and knowledge" and they have the "ability to use their knowledge in novel ways", which helps formulating effective responses to unexpected challenges. The empirical work by Morgan *et al.* (2015), Amaral *et al.* (2015) and Maynard and Kennedy (2016) also demonstrated that establishing a *learning culture* within the team (or organization) leads to *accumulating knowledge* from *past experiences*; and effectively utilizing this knowledge facilitates resilience when responding to future challenges.

Finally, whilst praising the utilization of *accumulated knowledge* to address challenges, researchers also paid attention to **the ability to formulate novel solutions**, particularly in the case of novel challenges. Weick (1993, p. 638) conceptualized this ability as *improvisation*, and argued that organizations should encourage developing this ability, as it is extremely useful when existing solutions do not work. *Improvisation* is also observed to be practiced by HROs by "recombining actions already in their repertoire into novel combinations" (Weick, Sutcliffe and Obstfeld, 2008, p. 47); and proposed by HRO researchers as one of the antecedents of resilience by enabling the organization to formulate the response to effectively address the challenge. Moreover, Kendra and Wachtendorf's (2003b, p. 45) investigation of the response of New York City's Emergency Operations Centre to the 9/11 attack demonstrated how improvised actions were necessary when there were unexpected challenges to respond to and planned actions did not work.

Another dynamic that is considered significant in relation to both team effectiveness (Kozlowski *et al.*, 1996; Kozlowski and Ilgen, 2006) and to team and organizational resilience (Stephenson, 2010b; Carpenter *et al.*, 2012) is the role of leadership. Leadership is among the factors that contribute to "team functioning and performance" (Vessey and Landon, 2017, p. 531); and hence, both theoretical and practical investment in understanding the effects of leadership on teams have been advocated (Kozlowski and Ilgen, 2006, p. 111). However, the leadership literature is vast; to do justice to it would have left me short of resources to explore my main concern, namely, collective contributory factors to team resilience. I therefore did not include 'leadership' among the contributing factors of team resilience in my conceptual model.

2.5.2 Team resilience and Team performance

The relationship between *resilience* and *performance* is acknowledged by many resilience researchers in the conceptualization of *resilience* in the form of *maintaining normal performance levels in the face of challenges*. Reason (2000, p. 770) framed this as: "withstand[ing]… operational dangers and still achiev[ing]… objectives"; Sheffi (2005, p. 13) explicitly stated that resilience is the "ability to… return to… normal performance level"; Horne (1997, p. 27) said that it is: "the ability… to withstand… without resulting in regressive/non-productive behavio[u]r"; and Pulley (1997, p. 2) took it the other way around and argued that: "A lack of resilience… results [in] lower

productivity and declining performance". Although not as explicitly as these, various other conceptualizations also imply that resilience leads to better performance. Freeman *et al.* (2003a, p. B6) asserts that: "resilience means the ability to spring back to original" and this "original" may also cover the higher prior performance levels. Sutcliffe and Vogus (2003, p. 97) propose that: "Resilience refers to the maintenance of positive adjustment under challenging conditions", and Mallak (1998a, p. 149) similarly refer it as: "the ability… to design and implement positive adaptive behaviours", in both of which these positive "adjustments" or "adaptive behaviours" could also mean increased performance levels. Coutu (2002, p. 52) described it as: "the skill and the capacity to be robust under conditions of enormous stress and change" and Cumming *et al.* (2005, p. 976) said that it is: "the ability… to maintain… identity"; and in these two conceptualizations one of the various elements of being robust and maintaining identity could be preserving high (or regular) performance levels. Lastly, even the features in Wildavsky's (1988, p. 147) fundamental definition could be matched with performance: an act of coping meant by the phrase "the capacity to cope" may be preserving performance levels or an act of "bouncing back" may be turning back to higher prior performance levels as in Freeman *et al.*'s (2003a) conceptualization.

Moreover, while elaborating on these conceptualizations, the researchers mention certain capacities that leads to resilient responses to challenges (or adversity or disruptions), and in turn, these resilient responses lead to preserved (or even higher) performance levels. For instance, Lengnick-Hall *et al.* (2011, p. 252) proposes that certain characteristics such as problem-solving routines, self-efficacy and a positive attitude towards learning leads to the improvement of the resilience capacity and this resilience capacity provides for the survival of entities in challenging conditions through maintained performance levels. Similar to this conceptualization, Gittell *et al.* (2006) investigated the airlines affected by the 9/11 terrorist attacks and concluded that abundance of relational reserves and adequate equipment of financial reserves are the sources of resilient responses and resilient responses are sources of recovery from the crisis, which they measured in the form of *performance recovery*.

In another example, Gomes *et al.* (2014) investigated the sources of team resilience and the outcome of team resilience is conceptualized as *performance*. As a result of their case study, they found *effective communication* as well as *team diversity* as the sources of resilience, and they concluded that understanding and achieving resilience, particularly in the context of complex systems with challenging dynamics, is the way to

improving performance. Jaaron and Backhouse (2014) also conceptualized resilience as a mediator mechanism between certain individual and organizational level inputs and team (and, ultimately, organizational) performance. While developing this conceptualization, they mentioned that the previous literature defines resilience as a capacity that allows the preservation of "satisfactory" performance levels (2014, p. 2029). Lastly, Weick and Sutcliffe (2007) wrote a book about how the concept they created and defined, [collective] mindfulness, leads, in various examples, the organizations in extreme and highly dynamic environments to be more resilient to challenges and this allows these organization to provide for desired production and performance levels.

Interestingly, in spite of this inherent inclusion of performance in the conceptualization of resilience, the relationship between resilience and performance has rarely been modelled and empirically investigated by resilience researchers (Lewis, Donaldson-Feilder and Pangallo, 2011, p. 7). Maynard and Kennedy (2016, p. 22) also draws attention to the scarcity of explicit empirical investigations of the relationship between *resilience* and *performance*, specifically at the team level, and points out the necessity of such empirical work given the assumed importance of resilience for performance. Moving from this, they propose a research model (2016, p. 63), where various organizational, individual and team level inputs leads to the emergence of resilience in the face of challenges and the demonstration of resilience leads to better performance along with certain other team level outcomes.

In the team resilience literature (in addition to the work by Maynard and Kennedy (2016)), and to some extent in the individual resilience literature, the conceptual elaborations and empirical investigation of resilience in relation to performance are relatively more abundant compared to the organizational resilience literature. The reason for this may be about the relative ease of data collection on performance at the individual and team level compared to at the organizational level. A second possible reason may be the inclination of organization resilience studies to extreme settings where survival is more crucial than performance or, in Weick's (1987, p. 112) words: "reliability is a more pressing issue than efficiency". No matter what the reason is, in the individual resilience and team resilience literatures, the conceptualization of resilience is more explicitly associated with performance and, although still scarce, more empirical investigations were carried out. For example, in their conceptual work, Alliger *et al.* (2015, p. 177) pointed out how, for teams, one of the most significant

negative effects of facing challenges is decreased performance along with decreased team cohesion and member well-being. They added that certain number of challenges may be overcome by many teams, however, in the face of enduring challenges, "only resilient teams can sustain performance and morale". Moreover, Amaral *et al.* (2015, p. 1184) also associated resilience with "overall performance" in their *team resilience* definition, particularly regarding performance as one of the outcomes of resilience. They suggested developing models that explain the relationship between resilience and performance as an important direction for future team resilience research. Finally, Bowers *et al.* (2017) proposed a team resilience framework, drawing on the work of Maynard and Kennedy (2016), in which they defined team resilience as an emergent state, which means it may only be observed when the teams are faced with challenges. In this framework, they treated team resilience as a mediator between individual, team and organizational level inputs and outcomes. The inputs, which serve as the precursors of the emergent team resilience, may be characteristics or processes. On the other hand, outcomes are positive adjustments in the face of challenges, one of which is "maintenance of performance".

Empirically, Furniss *et al.*'s (2011) work is among the first to investigate the relationship between team resilience and performance. In their work, they established a framework to explain resilience and tested it with a case study where they conducted an experiment on 14 nuclear operator crews. Their study concluded that situational awareness and slack resources in the form of broad action repertoire lead to resilient responses to the challenges faced, and these resilient responses allowed crews to manage **the variabilities in the performance**, and avoid performance decreases that could be caused by challenges. In another study, Meneghel *et al.* (2014) employed quantitative methods to investigate positive emotions, team resilience and team performance. 216 teams from 40 companies were rated their level of positive emotions (such as enthusiasm, optimism, satisfaction, etc.) and team resilience and the supervisors of the teams rated their performance. The results showed that team resilience mediates the relationship between positive emotions and team performance. This study is also significant in terms of acknowledging the existence and importance of *resilience* in less-extreme challenging settings as opposed to extreme environments, which most of the resilience research turned their face towards. Another quantitative study, at the organizational level, is conducted by Akgun and Keskin (2014), where they

investigated 112 firms from various industries with different market turbulence levels. Their study also validated a positive relationship between resilience and performance.

Finally, the empirical work by Youssef and Luthans (2007) is one of the rare empirical studies that investigated the relationship between resilience and performance. Contrary to the expectations and other studies, in this study, resilience was not found to significantly affect performance. The researchers explain the non-significance by the inadequacy of their sample size. However, there are two more important comments had to be made about this unexpected finding. Firstly, this research is on the individual level, and hence same results cannot be directly assumed at the different levels of organization. Secondly, and more importantly, the performance data is measured based on self-report tools. Regarding the investigation of the relationship between resilience and performance, an important problem is the frequent preference of measures of a self-report nature to obtain performance data. Vera *et al.* (2017, p. 135), as well as Youssef and Luthans (2007), highlighted this limitation of their study and suggested that if objective performance measures were used in the investigation, the results would be more reliable.

2.6 Research Model

In this study, my main purpose is to develop a generic (that is "transferable to different or future contexts" (Linnenluecke, 2017, p. 24)) yet comprehensive (that "uncover[s] a [broad] range of factors leading to resilience" (Linnenluecke, 2017, p. 24)) framework to explain resilience. With this framework, I basically aim to answer this question asked by Linnenluecke (2017, p. 16): "are there resources, capabilities and organizational structures that promote resilience in a wide variety of different contexts". With this purpose, my first objective has been to establish a resilience framework based on a comprehensive literature analysis summarized in this chapter, then, to bring this framework to an operationalizable format with the help of an exploratory study, and finally, to test this framework with my main study. Following these steps, I first established a process-focused framework to understand what I shall call the "**challenge-response" process**, which corresponds to an entities actions during the period from its initial encounter with the challenge to its elimination of the challenge:

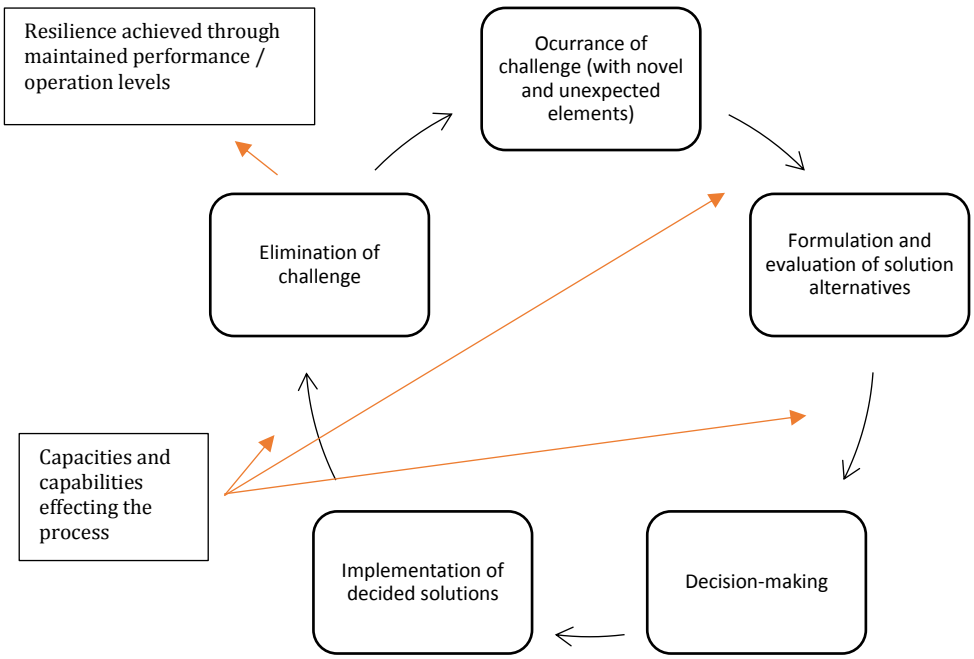

Figure 4. Resilience explained through organization challenge-response process

According to this framework (illustrated by Figure 4), when an organization is faced with a challenge with novel elements, it first has to come up with solution alternatives. The formulation of accurate solution alternatives requires a good understanding of the context (reflected by *situational awareness*), which is only possible with *the effective processing of necessary information*, which is facilitated with *effective communication*. While the solution alternatives are formulated, *the knowledge from past experiences* may be utilized, however, this knowledge should be supplemented with a novel combination of actions using *improvisation* to also address the novel elements of the challenge. The decision regarding which solution to implement also requires a sound understanding of the challenge and the circumstances around it. In order to implement the solution, the organization has to act in a cohesive and coordinated manner with *collective mental models*. Elimination of challenge (demonstrable by maintained performance levels) leaves the organization with *the newly acquired knowledge* which may improve the 'elimination' process when face with the future challenges.

Further to this, I have established the framework that illustrates the precursors that lead to the manifestation of resilience. In this framework, I considered resilience as an *emergent* capacity, which is only demonstrable when certain predetermining factors are in place (Maynard and Kennedy, 2016, p. 8). This explains why the resilience capacity is only demonstrated when faced with challenges and why it is extremely hard to observe and measure it. Thus, I also wanted to investigate its observable and

operationalizable outcomes and identified *performance* to serve this purpose (section 2.5.2). Figure 5 illustrates this framework, where *resilience* is portrayed as an emergent capacity and *performance* is included as its observable and operationalizable outcome.

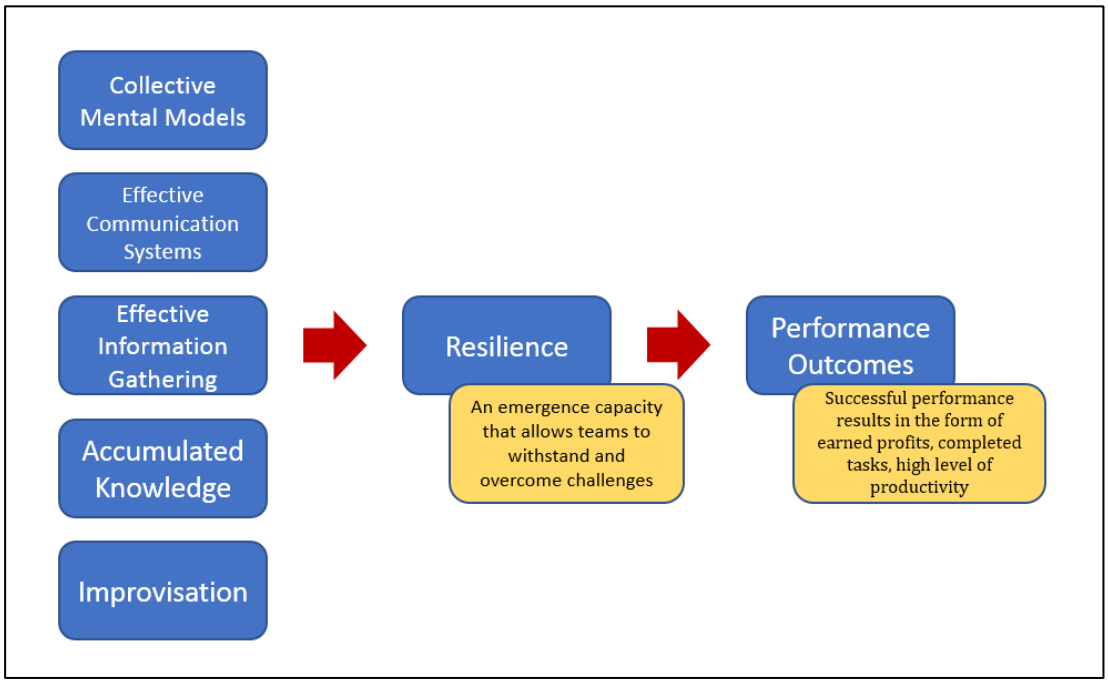

Figure 5. Conceptual model

According to this framework, resilience is conceptualized as a capacity to provide for satisfactory performance outcomes while operating under challenging, stressful and/or disruptive environmental conditions. In other words, for an entity to be successfully operate in the face of challenging conditions, it needs to demonstrate resilience capacity that emerges as a result of a combination of certain precursor capacities and capabilities. As mentioned before, prior literature on resilience proposes various precursors and throughout the empirical part of this study, the effects of these precursors on resilience were investigated to test and improve the model. Nonetheless, based on the literature analysis I conducted with regards to the antecedents of resilience (which is elaborated in section 2.5.1), in the tentative framework these precursors are identified as;

- *collective mental models* ('virtual role systems' in Weick, 1993; 'collective mind' in Weick and Roberts, 1993; 'coordination' in Horne and Orr, 1997; 'role

dependence' Mallak, 1998a; 'shared mental models' in Maynard and Kennedy, 2016; 'transactive memory systems' in Bowers *et al.*, 2017),

- *effective communication systems* ('respectful interaction' in Weick, 1993; 'communication' in Horne and Orr, 1997; 'effective communication' in Sutcliffe and Vogus, 2003; McManus *et al.*, 2007; Furniss *et al.*, 2011; Stephens *et al.*, 2013; Maynard and Kennedy, 2016; Bowers *et al.*, 2017),
- *effective information gathering* ('attention to environment' in Meyer, 1982; 'critical understanding' in Horne and Orr, 1997; 'constructive sensemaking' in Lengnick-Hall and Beck, 2005; 'situational awareness' in McManus *et al.*, 2007; 'attention to weak signals' in Weick, Sutcliffe and Obstfeld, 2008; Furniss *et al.*, 2011; Alliger *et al.*, 2015),
- *accumulated knowledge* ('competence' in Horne and Orr, 1997; 'accumulated knowledge' and 'learning culture' in Sutcliffe and Vogus, 2003; 'information and knowledge' in McManus *et al.*, 2007; 'using existing knowledge' in Weick and Sutcliffe, 2007; 'past experience and training' in Furniss *et al.*, 2011; Morgan, Fletcher and Sarkar, 2013; Amaral, Fernandes and Varajão, 2015; 'learning culture' in Maynard and Kennedy, 2016),
- and *improvisation* (Weick, 1993; Kendra and Wachtendorf, 2003b; Sutcliffe and Vogus, 2003; Boin and McConnell, 2007; West, Patera and Carsten, 2009).

Combining these insights, with this framework, I propose that with these capabilities, entities (in this study, teams) will be able to demonstrate resilience to the challenges, which, in turn, will prevent the deterioration of performance in challenging conditions. I included these capabilities in this conceptual model as general contributing factors to team resilience. I did not assume that their contribution to resilience was equal and/or direct. Rather I aimed to investigate the nature and level of these contributions throughout my research. This framework was further improved with the exploratory study and was tested and finalized in the main study.

2.7 Conclusion

The purpose of this chapter was twofold: to set a conceptual background for the following empirical work and to develop a testable model for the study. To achieve the former, first, I conducted a review of previous studies about resilience. I provided a brief history with regards to how *resilience* was started to be used in the academia,

accounting for its journey from material science to all the way to the organization studies. I also provided various characterizations in different fields in that regards (section 2.2). With regards to its conceptualization in the organization studies, initially, I discussed the work that constituted its roots, namely, crisis management, positive organizational scholarship and the general resilience literatures. Following this, I accounted for the resilience research in two groups of settings, namely high-risk industries and organizations experiencing major crises, on which almost all resilience research has concentrated.

Once I summarized the background of the resilience literature, I laid out the limitations and gaps waiting to be addressed in the resilience field. I identified the immediate gap as the lack of a comprehensive framework to explain resilience, particularly for a wider population of organizations facing less extreme operational challenges compared to the organizations in the extreme settings, concentrated by the previous studies. In this regard, since for organizations in less-extreme settings performance is a compelling issue (as reliability or survival is not an issue), I also identified the nature of the relationship between resilience and performance as another important gap to be addressed. I indicated the issues I addressed in this research with regards to these gaps in the following section. Within this scope, I mentioned the studies that investigated the mechanisms that explain resilience and its relationship with performance.

In the continuation of this section, I provided the research model which aimed to guide my investigation to answer the research questions I identified. This model was established based on the propositions and findings of the studies that investigated the mechanisms of resilience, the capacities and capabilities that leads to resilience, and the outcomes of resilience. Using this model, I tested the relationship between various *capacities and capabilities* and *resilience* as well as *resilience* and *performance* as an outcome. The results of these tests are presented and discussed in the following chapters.

3 Exploratory Study – Escape Games

3.1 Introduction

As described in section 2.4, there are three important limitations of methods used in previous empirical investigations of resilience: the non-generalizability of the findings to wider organizational populations, a lack of direct (or real-time) data collection with regard to the mechanisms of resilience, and extensive dependence on self-report measures. In the empirical part of my research, I intend my research design to address these limitations. With this intention, first, I decided to investigate resilience to high-probability low impact disruptions (Sheffi and Rice Jr., 2005, p. 43), which are mainly caused by the challenges of daily operations. Such challenges are faced by many organizations; hence, data on resilience to these challenges may be applicable to a wide range of organizations. Second, I decided to conduct a study with a relatively large sample compared to previous resilience studies, which would enable me to employ quantitative methods, to compare and contrast across multiple, comparable units in a relatively controlled setting and thereby obtain (more) generalizable results. Thus, to be practical (both considering time and money), I decided to use relatively small and manageable organizational units and opted to use **teams** as my unit of analysis. This decision also served the purpose of collecting real-time as opposed to post-hoc investigation. In this regard, I reasoned that team processes would be easier to map out in a holistic manner than would comparable processes in large organizations; which would require me to be at several places at the same, even for a single organization. Finally, I also wanted use data independent from self-reports where possible, so in my research design, I wanted to employ direct observations and objective measures, particularly to measure performance.

Given my intention to collect real-time data on a relatively large sample, it appeared impractical to design a field study. As I elaborated before, it is difficult to observe the challenge-response processes in multiple units in real life and this may be one of the reasons why post-hoc case studies are so dominant in the resilience field. However, the mechanisms of resilience may not be easily revealed by these post-hoc investigations, as actors may either forget to account for them, may hide them in order to hide their mistakes or may not even be aware of them (Weick, 1976, p. 15; Alesch *et al.*, 2001, p. 42; Lewis, Donaldson-Feilder and Pangallo, 2011, p. 6). As a solution to this, I decided to conduct my investigation in a more controlled setting, in which I was aware of the

nature and timing of the challenges faced by the teams. This allowed me to collect real-time data. In addition, since these challenges did not have negative outcomes with very significant consequences (such as injury, loss-of-life, financial losses, layoffs, etc.), participants would not be as disturbed by data collection as they would if they were subject to research in a real-time setting where their actions had major consequences. Of course, an important downside of this decision is the difficulty in finding an artificial setting where participants still feel sufficiently challenged despite not facing real life consequences.

My search for such an artificial setting lead me in the first instance to "escape games", where teams of up to six people are locked into a room with a series of puzzles and problems in it. Solving these puzzles and problems leads the team to a key to open the locked door of the room. They have 60 minutes to reach the key. They fail the exercise if they do not reach the key in the given time. I considered this setting because it is a setting that causes nervousness, and even stress on some occasions, according to the testimonials of those who have played it (Nicholson, 2015, p. 12). Since people has a very limited idea with regard to what expects them in the room and they might be nervous about not being competent enough to unlock themselves in the given time, I anticipated that 'escape game' setting might be sufficiently challenging for the research participants. Moreover, solving the complex and connected puzzles in the room requires participants to gather information from the surroundings, communicate the obtained information, collectively make sense of the situation and improvise solutions using this collective sensemaking capacity. Thus, responding to the challenges in this setting appeared to require capabilities similar to those of team resilience. I therefore decided to test the framework I established as a result of my literature investigation in this setting.

I conducted investigations with two teams as an exploratory study in the escape game setting. As a result of these investigations, I concluded that the escape game setting was limited in certain ways in terms of revealing the mechanisms of resilience I was investigating. Thus, I did not continue my main study with the escape game setting. The exploratory study generated several insights and helped with the design of my main study in a number of ways. First, it revealed the strengths and weaknesses of artificial research settings with regard to resilience research. Second, it demonstrated how resilience research could be done in the most effective way in such settings. Third, it indicated the type of data collection methods that were most feasible and beneficial to

use while investigating resilience in artificial settings. In addition to the methodological insight I gained and in spite of 'Escape Game' setting's limits in terms of revealing the mechanisms of resilience, I observed teams responding to challenges in this study. Hence, this exploratory study was also fruitful in terms of testing and improving the research model I developed, particularly in terms of bringing it into an operationalizable format.

3.2 Methods

3.2.1 Nature of Escape Games (Escape Room)

Escape games are physical versions of the videogames in which characters are trapped in a room and players must extract information (from the surroundings) that will enable them to unlock the room and escape (*Escape the room*, 2006). Instead of the virtual characters in the videogame, in physical escape games, people, themselves, - as teams - are locked into a physical room full of information in the form of problems and puzzles. In these escape games, people need to free themselves from a locked room within a time limit, by decoding information in order to reach to the hidden room key and thereby escape.

According to information provided by Escape Room Directory website (*Escape Room Directory*, 2016), there are more than 2500 Escape Game facilities worldwide that span 1191 cities and 92 countries. Most of these facilities offer a number of rooms with different themes and scenarios. There are rooms that imitate prison cells, dungeons and space stations (*Escape Room*, 2013) as well as non-themed rooms with several puzzles embedded within them. Real life escape games were first initiated in Asia with earliest facilities being established around 2006 and they became popular after 2010 all over the world (Nicholson, 2015).

In the process of playing Escape Games, participants are first required to gather as a team. After the establishment of the team, a date is set with the facility and the room booked for the team for the duration of the exercise. On arrival at the facility, an experienced controller briefs the team about the exercise, particularly to prevent team members damaging themselves or the room (such as trying to break windows, move furniture, etc.). However, briefings are limited in order not to give away clues about the scenario.

Once the team enters into the room, it is locked from the outside and the countdown starts. Generally, teams are given 60 minutes to find the key and escape. Throughout that time, a controller monitors the room via a video camera and only intervenes with the exercise if (a) an unexpected problem arises or (b) the team is unable to solve clues and asks for help. Nicholson's (2015) survey suggests that only around 41% of the teams are able to successfully unlock themselves from the room within the time available. This suggests that solving the problems and the puzzles embedded in the rooms require collective problem-solving skills in the form of searching for clues, accurately combining different clues and making interpretations from these combinations, formulating solutions with these interpretations and applying the solutions to overcome the problems. I presumed that all these activities require a team to construct collective mental models, establish efficient communication and information gathering systems and formulate improvised solutions; and, by that, demonstrating resilient responses to the unexpected challenges. This may be why escape games are popular as a corporate activity (Caramela, 2018), as with these exercises they test and improve their collective skills and capabilities (French and Marmor Shaw, 2015), hopefully improving productivity and performance at workplace.

3.2.2 Research design

For the exploratory study, I carried out two single-team exercises with one team entered into the exercise at each run. By using the escape game setting in these exercises, I aimed to observe collective behaviour while teams solved problems on the way to reach their goal of escaping within one hour. As observed by several resilience scholars, resilience is about efficiently responding to challenges while operating to complete a mission (Lengnick-Hall and Beck, 2005; McManus *et al.*, 2007; Weick, Sutcliffe and Obstfeld, 2008). Adopting this view, many scholars have argued that dealing with unexpected challenges that "fall outside the set of disturbances the system is designed to handle" (Comfort, Boin and Demchak, 2010, p. 8) requires resilience (Williams *et al.*, 2017, p. 742). Thus, considering the fact that I will be observing teams that are facing unexpected challenges, I hoped that the exploratory study would reveal the mechanisms of resilience.

In the two exercises I conducted, the first one resulted in success and the team unlocked the door in 48 minutes. The second team, on the other hand, was unable to find the key within 60 minutes which meant that they 'failed' the exercise. Descriptions

of these two exercises are provided in section 3.4. The contrast between the results of two runs yielded useful insight into the actions that facilitate resilient responses to challenges faced during operations.

3.2.3 Data collection

Data collection involved pre- and post-exercise discussion sessions and video recordings of the exercises. I met with the teams one hour prior to the exercise and held pre-exercise discussions in order to understand the stress levels and expectations of team members along with the team dynamics prior to the exercise. Then the exercise was carried out and recorded (with both visual and audio recordings). After the exercise, I held post-exercise discussion sessions to explore participants' views of the exercise and of the behaviour of their team.

During the pre- and post-exercise discussions, I employed a semi-structured interview method. With the help of predetermined questions (Appendix 10.2), I aimed to understand participants both individually and as a team. I asked questions to understand how participants feel regarding the exercise and their team. I also asked questions to understand what collective capacities they envision to develop and use throughout the exercise. I did not intervene with the flow and the direction of the discussions, but facilitated the progression by introducing new questions when necessary. I audio-recorded the discussion sessions and took notes during the discussions. I used these recordings and notes to supplement the qualitative analysis of the video recordings of the exercises.

3.2.4 Sampling

The sampling method I employed for this exploratory study was 'convenience sampling', namely selecting the participants of the study according to how easy it is to access them (Salkind, 2010) rather than considering how representative they are of the population investigated (Vogt, 2011c). This is a non-random sampling method and, hence, has advantages and disadvantages. In order to quickly test the escape game setting as a possible research setting and to gather information about the methods and measures to be used in the main study, I used convenience sampling because it was easy and economical to acquire participants by this method. It is not straightforward to suggest generalizability for this method of sampling (Salkind, 2010), however my purpose with the exploratory study was to facilitate the main study (by an initial

testing of the research model and planned research methods) rather than generating generalizable findings.

3.3 Implementation

My first step was to form the teams. I directly approached to the PhD students at University of Edinburgh Business School asking for their participation in the exercise and first five volunteers made up the first team to run the exercise. On the arranged date, I first conducted the pre-exercise discussion. During the pre-exercise discussion, participants revealed their thoughts and expectations about the exercise they will enter in an hour. They also revealed how excited and/or stressful they were both verbally and with their body language. I only intervened with the discussion (a) when I wanted to ask follow-up questions about the subject being discussed and (b) when participants had nothing else to say on that subject and another one could be introduced. Once in the exercise, a controller and I monitored the exercise from outside the exercise room for the complete duration. As an experienced runner of the exercise, the controller explained the implications of actions taken by the team as the exercise proceeded. I took note of all this information. The team successfully completed the exercise in 48 minutes. After the exercise, participants discussed their experience and contrasted these with their expectations before the exercise. They, then, discussed the actions taken by the team and how these were useful (or not) in solving the problems and puzzles. Participants explained, from their own perspective, the reasons behind their ability to effectively address to the challenges as well as the reasons behind the level of their performance.

The volunteers for the second run were drawn from a business school in Turkey and five volunteers formed up the second team. The second exercise was carried out in Turkey using a different Escape Game scenario to the UK exercise. Although the scenarios were different, the difficulty of the problems and puzzles were similar and both teams were given the same time limit (60 minutes) to complete the exercise. In the pre-exercise discussion session of the second team, I introduced the same questions as the pre-exercise discussion of the first run. Participants talked about their expectations, their excitement and their stress. After the discussion, participants entered in the exercise. The exercise lasted for 60 minutes, all of which was recorded and monitored by the controller and myself. Again, the controller shared her opinion of

the implications of the actions taken by the team. This team was unsuccessful in that after 60 minutes they had not located the key to unlock the door. Thus, the post-exercise discussion was mainly about the reasons they thought caused their failure; and about actions they could take instead to change the result. I wrote a detailed description of both discussions afterwards.

3.4 Detailed accounts of exercises

3.4.1 Exercise 1

I carried out the first Escape Game exercise at a facility in Edinburgh, United Kingdom on March 7, 2015. The exercise lasted from 11:29am to 12:17pm, 48 minutes in total. The team had to solve eight sets of puzzles (in the form of locked cupboards, briefcases, boxes, coded writings, etc.). They reached the key and completed the exercise successfully.

As soon as the team stepped into the exercise room, the members scattered around and started to carefully examine the room in order to find clues that would lead them to the key. They gathered everything they had considered as clues on a table that was sitting in the middle of the room. From the moment the exercise started, the team members communicated their individual findings to the others so that everybody had a cognitive map of the team's progress constantly. This communication was sustained until the end of the exercise, especially in the form of reporting individual findings verbally out loud so that other team members could hear them. Quotes such as "I… got two [postcards] over there", "[there is] not anything behind the TV or on these shelves" or "Is there something in the lampshade?" were constantly uttered by the team members, providing continuity of communication.

The initial passwords they aimed to find were numerical ones to open a number of locked cupboards with padlocks on them. Thus, they initially targeted different hour indications of the various clocks in the room (such as 6:05, 7:05, 4:30, etc.). They used a white board to record what they had found in order not to forget it and to be able to detect the connections between different clues more effectively. Once they recorded the clues on the board, they discussed possible interpretations in order to reach to the correct one. The team generally worked in subgroups of 2-3 people, which allowed them to deal with multiple clues at the same time and hence work more quickly and

effectively. They only got together as a team when there were bigger and more complex problems to deal with that required brainstorming, new idea generation and option evaluation.

In terms of tangible outcomes, the team made a slow start. They overcome the first puzzle (a numerical password for one of the padlocks) only after 13:56 minutes passed. Since they spent more time on this than an average team spends, the controller provided an extra clue via a TV screen. The second puzzle also involved a numerical password to open another locked cupboard. Unsuccessful attempts cost them a lot of time and because of this, the controller provided two additional clues. The problem initially was poor interpretation of the clues, and then, the inability of a team member to physically unlock the padlock with the correct password combination. This failure led them to look for other possible password combinations and lengthened the time to solve the problem. With reinforced confidence in their initial finding provided by the additional clues from the controller, they tried the open the locker once more and succeeded after 21:55 minutes into the exercise.

With additional findings from the unlocked cupboards, the team faced a complex decoding activity in the third puzzle. They did not need to formulate novel solutions or discuss alternatives for this puzzle. All the team needed to do was to decode encrypted writing using decoding clues. In more detail, there were certain Greek letters that were the codes for different numbers and certain algebraic expressions were given for the team to work out the numbers that the Greek letters were codes for. The purpose of the puzzle was to unlock a box with a three-digit password (a simple example: 3Δ=9, Γ+Δ=4, password: ΔΓΓ). They were extremely quick and efficient in decoding this, solving the puzzle in 2:21 minutes.

The box revealed a Cryptex (a portable vault with a coded padlock, used to hide secret messages) with a five-letter code to be solved. At this point, the team could not associate any clue on hand with the solution of this puzzle and started to brainstorm ways to solve the puzzle. The problem was their inability to discover a briefcase between a table and a sofa. This locked briefcase had to be opened, because the clues inside it were needed to solve the Cryptex. Being unaware of that fact, they discussed how to solve Cryptex for quite some time. It took another clue from the controller for them to locate the briefcase, but once noticed, they were very quick to associate the

relevant clue (a picture with briefcase and three shapes, side counts of which were the three numerical password codes of the briefcase–e.g. Δ□◊=344-) and open it.

After the discovery of the briefcase and the clues inside, it became easier for the team to associate the clues with the remaining puzzles. They needed to decipher another complex clue to discover a code for another box and in a coordinated fashion, they quickly discovered the code. The box revealed other items and clues that lead the team to the discovery of the five-letter code of the Cryptex. The Cryptex revealed a key to open a glass box that contained a safe with a door key in it and an ashtray sitting on the safe. According to the instructions, opening the safe required a four-digit code. This was the last puzzle and the only clue was the ashtray. They immediately tried the isolate the objects that they did not use throughout the exercise and that lead them to a shelf containing books and CDs. They looked for a book or a CD, which had a name associated with an ashtray, such as 'ash', 'cigarette', 'fire', etc. Finally, they discovered an Album by the group 'Ash' named: 1977. Entering the code on the safe opened it. This revealed the key and ended the exercise, after 47:49 minutes.

3.4.2 Exercise 2

The second exercise took place at another Escape Game facility located in Samsun, Turkey on July 4, 2015. It started at 13:55 and lasted until 14:55 with the team failing to reach the key and complete the exercise. This group was also had to solve eight sets of puzzles; however, they could only solve six of these. Just as the first group, the second group started by scattering around and searching the room and agreed to place all the clues on the table. They also counted the locks so that they would know approximately how many puzzles they needed to solve. However, the team did not adhere to these ideas as the exercise progressed, and members acted in ways that were independent and disconnected. This issue grew as the exercise progressed. There were very few verbalizations of individual discoveries. In addition to this, members appeared not to listen to or to try to make sense of what other members said. Therefore, most of the time, individuals only had the partial information that they themselves had obtained from the clues, and even then, they generally misinterpreted this information. This caused them to waste their time by searching the same places and trying the same solutions repeatedly, either individually or in sub-groups. For instance, after they had unlocked an old piece of luggage, there were four distinct instances (each by a different

group member) where this luggage was searched again for clues because no-one had called out what they had found (or had not found) inside.

Because of these impediments, the team took 25 minutes to solve the first puzzle of the exercise and then only with a couple additional hints from the controller. In this first puzzle, they needed to collect four transparent decoding sheets and decode a password with them to open a box. Searching the entire room, they gathered only three of the sheets, but without knowing they were missing one, they could not decode the password. The controller told them about the missing sheet, which they then found. However, they still could not interpret how to use cards correctly without further help from the controller. Late success with the opening of the lock motivated the team to work together and in a more focused manner, so, in 5 minutes, they solved the second puzzle. For the second puzzle, the team quickly gathered the numbers by identifying the numerically coded differences between two seemingly identical pictures. The clue gathered from the drawer led the team to crack the code on a retro telephone, and this code opened the locked cupboard. The cupboard revealed an old piece of luggage and several clothes.

In the luggage, there were books. One of these books was the key to solve the fourth puzzle and the team had to identify this from an earlier mention of its author on a card along with some numbers. The fourth puzzle required decoding a password by applying the numbers in the card in page-line-letter format and find the written version of the numerical password by using the letters obtained by this coding (e.g. letters of "onehundredandtwo" would be identified to get the code "102"). The team was very slow in interpreting how to apply the clue to discover the code, and could only manage it with a couple hints from the controller. This fourth puzzle, which was used to open another drawer, took more than 15 minutes of their time.

From the drawer, they gathered a memo saying: "the time is running out, tidy up the stuff". One member was quick in realizing that the first part of the memo referred to the numerical expression of the time in a digital clock in the room (i.e. 4:31→ 431). However, the team could not find any lock in the room to use that code, and they could not interpret the second half of the memo. Only after a hint by the controller, they realized that there was a hidden door behind clothes hung in the cupboard. The door was opening to another room, which was filled with three more puzzles. The group could step into the room with less than 10 minutes left in the exercise and could only

solve one of the puzzles. Using a key, they gathered by solving the previous puzzles, they opened the bookcase in this second room. A clue inside revealed the prefixes "sor-" and "dis-", which they discovered to correspond to the 7th and 21st books in an encyclopaedia set (as these prefixes were writing on the cover of these books to show which words described in these books). Using the code "712" they opened the briefcase. By the time they reached to this point, the team still had two puzzles left to be solved. Being left with this much work and very limited time, they lost motivation. The group started to demonstrate signs of desperation and frustration, especially after they realized they had only five minutes left and a puzzle that they were nowhere near to solving. The exercise was terminated by the controller when they reached the time limit.

3.5 Analysis

For the analysis of my exploratory study, I used the video recordings of the exercises, the notes I took while watching the exercise with the controller, the audio recordings of the pre- and post-exercise discussion sessions, and, finally, the notes I took during these sessions. Examining all these sources, I first created a timeline for each team, with regard to what they achieved during the exercise. Then, I contrasted these timelines, and marked the differences between the teams in terms of these achievements. Following this, in the data, I searched for the reasons of these differences. Using the insight from the literature and combining these with the information from the data, I aimed to understand the factors that contributed to overcoming the problems and puzzles of the exercise and the factors that caused delays and inefficiencies in team processes.

The purpose of the exploratory study was to reveal mechanisms of team resilience and to test the explanatory power of my conceptual model, in order determine the approach and measures to be used in the main study. Two exercises were carried out in this exploratory study; one resulted in success and the other in failure. The first team appeared to display certain capacities and capabilities, which enabled them to better respond to the challenges and this, in turn, led them to solving puzzles quickly. Lacking those capacities and capabilities, at least to a sufficient level, the second team found it harder to hold themselves together as a unified force in the face of the challenges. Therefore, not being able to act collectively in an effective way, the second team was

unable to respond to the problems and puzzles effectively, was slow to solve the puzzles and, eventually, failed to complete the exercise within the allowed time. Thus, I discuss the finding in terms of collective dynamics that are revealed to contribute to resilient responses to the challenges faced by the teams. However, before discussing these dynamics I illustrated the comparability of two exercises implemented.

3.5.1 Comparability of the two exercises:

The completion times of two exercises may not be exactly comparable since the tasks and the scenario in each one was different. However, the exercises had a certain level of similarity, as shown in Table 2:

Attribute	Exercise – 1	Exercise – 2
Amount of time given	60 minutes	60 minutes
Number of puzzle series to be solved	8	8
Nature of the puzzles	Codes and passwords	Codes and passwords
Tasks	Discoveries, calculations, association, research	Discoveries, calculations, association, research
Help	Given in a standard manner to all teams in written form (via a TV screen)	Given considering unique circumstances, verbally by the controller (via speaker)
Number of clues provided by the controller	5	6
Number of rooms	1	2

Table 2. Comparison of two exploratory exercises

Table 2 demonstrates that two exercises are comparable in terms of the time it took teams to finish the exercise. Considering this, in general, first group was quicker in solving through the puzzle sets. In total, first group finished the exercise in 48 minutes whereas the second group had not completed the exercise after 60 minutes. Considering the completion time of individual puzzle stages, both groups were slow in solving the first puzzle and this may be expected due to initial adjustment to the exercise; the first group solved the first puzzle in 14 minutes whereas the second group only solved it after 25 minutes and then only with significant help from the controller. Both groups became more effective as the exercise progressed but this was not enough for the second group to complete the exercise.

3.5.2 Validation of resilience precursors identified in the conceptual model

3.5.2.1 Establishment of an effective communication system

Providing the effective communication within a team is one of the most important elements of the ability to quickly respond to challenges (Weick, 1993, p. 642). Resilience scholars have proposed various activities that facilitate the establishment of an effective communication system such as *interacting* (Weick, 1993), *interrelating* (Weick and Roberts, 1993), *sharing* (Maynard and Kennedy, 2016), *providing feedback* (Horne and Orr, 1997), *transmitting (ideas, thoughts, knowledge)* (Bowers *et al.*, 2017), *expressing* (Stephens *et al.*, 2013), etc. All these activities allow actors to combine the pieces of the comprehensive knowledge required to formulate resilient responses to challenges. Team members may individually have different pieces of information necessary to respond to a challenge (in the form of puzzles in escape games), but without the ability combine these pieces, it may be impossible to provide an effective response.

In the first team, each individual informed the others of the progress they were making, so that everybody had a complete 'cognitive map' of what was going on. They also always checked in with each other about their progress even though sometimes they were working on different things simultaneously. Whilst doing this managed to avoid interrupting the flow of each other's work during these interrelations. In contrast, individuals in the second team generally did not seem to consider it necessary to inform others of their progress, which led to delays in solving puzzles. For e.g. while searching for clues the same places were investigated by several group members at different times because nobody informed the others that s/he had already investigated that place. A dialogue between two members strikingly illustrates this communication issue, along with a suggestion of lack of trust:

> *Member A: "I found it, I found the answer it is 6990."*
>
> *Member B: (laughs loudly) "we've seen it, we've tried it, it does not work"*
>
> *Member A: (surprised and not convinced) "You did?"*
>
> *Member B: (not very happy that Member A is not convinced) "if you want, try it again!"*

Maybe more importantly, for the second team, the lack of proper communication manifested itself as not paying attention to the ideas of other team members. Thus, their ability as a team to combine the ideas of different members was notably impeded and this prevented them from reaching solutions easily. For example, individuals constantly offered ideas regarding solutions to the puzzles but others generally did not pay attention to these ideas; some ideas were lightly mocked by other members. In contrast, every idea was valued, discussed and tried in the first exercise without judgement or discrimination.

Additionally, team member interactions were very frequent and thorough in the first team, which helped the team to be coherent and provided a comprehensive cognitive map of the situation. Particularly, they discussed possibilities of what a clue might mean and also what it did not mean. These discussions helped them figure out possible solutions and also helped limit thinking in an 'overcomplicated' manner. For instance, one clue was a postcard with Greek letters on it, which corresponded to certain numbers. However, before understanding that they need to decode numbers that correspond to these Greek letters, one participant thought that the Greek meaning of these letters might be important or not and asked another member of the team (who happened to be Greek) whether the letters are meaningful together. At that moment, another participant pointed out that the meaning of the Greek letters could not be important, as most teams playing the Escape Games would not have any Greek participants. This was a good example of how the team eliminated a possibility and avoided losing time whilst interpreting the clues.

Another example of this occurred when the first team was generating possible solutions to the Cryptex which they found after solving the third puzzle. The Cryptex had a five-letter code that they had to identify. Without realizing that they were missing the briefcase which included clues to solve the Cryptex, they tried to generate several alternative ways to solve it. At one point, one member suggested using a binary numerical system to decode the Cryptex but others immediately (but kindly) pointed out that it would be extremely hard to deal with a binary system, so that this could not be the right way to solve the puzzle.

In contrast, while trying to figure out some page-line-letter coding, the second team also considered various complicated coding schemes, but they did not think about whether solving them was feasible within the given time. They spent a lot of time in

trying to decode clues using these complicated coding schemes. Only after suggestions from the controller did they realize that they were using inappropriate coding schemes.

3.5.2.2 Establishment of the collective mental models

In order for an entity to effectively act as a single unit while responding to the challenges, the entity has to possess the collective knowledge of each member's current operations and situation (Bowers *et al.*, 2017, p. 10). Some sharing of this collective knowledge across members of the team entity is also needed if members are to be able to fill in for each other when necessary (Weick, 1993, p. 640). As I mentioned in section 2.5.2, this shared collective knowledge has been conceptualized in different ways by various scholars (e.g. *collective mind*, *shared mental models, etc.*), and proposed as one of the enablers of resilience by enhancing coordinated collective responses.

Through their systematic approach and organized actions, *the first team* appear to have established a good sense of collective mental models, partly due to the effectiveness of the communication system that they employed. Using this system, they frequently evaluated the whole situation so that they had the 'big picture' in their minds. This is how, for example, they were able to come up with the last four-digit code to be solved. When they were brainstorming about how to discover the last code, one member asked: "What else is left that we haven't used?" referring to the objects in the room and others replied: "the book shelf". Their search of the shelf led them to a CD whose title (1977) provided the code. As well as being aware of their overall progress and making sense of all the clues they acquired, in each individual task, they were quick and efficient as a group to comprehend the situation and respond to it. This, for instance, allowed them to quickly go through the Greek letter encryption.

The second team was much less successful in establishing such a sense of collective mental models. They became extremely caught up in details, and focused on the immediate solution of individual puzzles without thinking about how these might fit together. They were obsessed with getting out of the room without thinking about how each stage might lead on to another. Thus, they never paused to evaluate the situation, where they were, how much they had already been through, how many of the clues they had already used, how many boxes and closets/cupboards they had opened in order to assess how many tasks might remain. This was particularly manifested by attempting to apply every clue they found to every puzzle without trying to form associations between individual clues and the narrative of the puzzle. For example, in

the page-line-letter puzzle, the clue explicitly stated that a specific author was applied the coding in his books. However, they still tried to apply the decoding to books that did not belong to that author.

As mentioned in section 2.5.1, the ability of a group to develop, maintain and access collective knowledge has been conceptualized as *transactive memory systems* by Wegner (1987), and Lewis (2003, p. 590) suggested that this latent concept is manifested in three operationalizable attributes: *specialization*, *credibility*, and *coordination*. According to Lewis (2003, p. 589) *specialization* is differentiated knowledge of members; *credibility* is members' trust in the other members' knowledge and expertise in these different areas; and *coordination* is the collective utilization of this diverse expertise and knowledge. Using this conceptualization, I analysed the two teams in terms of their transactive memory systems.

Specialization:

Specialization is significant for operations that require multiple areas of expertise and multitasking. Although teams do not need to demonstrate deep expertise in specific areas in the escape game environment, multitasking and parallel working is a must for the teams for the many parts of the exercise if they are to complete it on time. Considering this, the first team was efficient in breaking into subgroups to specialize and even allowing individuals to specialize when required. For instance, at the beginning of the exercise they decided that each member first needed to work by themselves to collect as many clues as possible. Moreover, later in the exercise, they frequently divided themselves into subgroups of two or three to work on different tasks simultaneously. Thereby, they were able to solve different puzzles simultaneously and obtain several clues that contributes to the solution of the subsequent puzzle.

The second team, on the other hand, was not so specialized. In general, members were either wandering about on their own without engaging in a useful action or everyone was working as a whole group on the same puzzle which did not usually require so many people. On almost no occasions did I observe this team to be working on more than one task at a time in subgroups. The only exception to this was when solving a puzzle did not require the attention of the whole group. At these times, the individuals whose efforts were not needed tended to wander around, apparently with their minds still on the current puzzle rather than looking for fresh clues.

Credibility:

When working on a task as a team, it is important to trust the expertise and judgements of the other members, especially if different individuals or subgroups are working on the different parts of the task. When members trust the expertise of other members, they do not require cross-checking the work completed by them and the information they communicate. This, in turn, speeds up the challenge-response process. Such trust was observable in the first team as they confidently worked on different puzzles as subgroups. The suggestions coming from different members and subgroups appeared to be regarded as credible and were implemented when appropriate. The quotes from the post-exercise discussion reproduced below demonstrate the existence of such 'trust' and its importance:

> *"... when discussing possibilities, nobody ever said something like 'ow, whatever' and instead everybody was like 'Ok, yeah, let's try that'..."*
>
> *"...it was like a sequence... at the beginning the groups split up... then gather when we finish that... so the other group was already finished with the writing... so we could directly go there... so it was flowing... not interrupted"*
>
> *"the best thing was we tried to solve the problem, we did not compete with each other"*
>
> *"...it was always like 'let's think about this', 'we can do this', 'what do you think', it was always like this, the team, which to be completely honest surprised me about myself, cause I usually like to control... I... felt like it did have to do with 'trust', in the sense that I trusted each and every one... to figure it out..."*

This trust was also appeared to be strongly reinforced by the effective communication system as everything that was thought or discovered by individuals was constantly communicated to the group.

Although the second team also had a positive environment and generally good member relations, there appeared to be a lack of confidence in the suggestions of others. One member in particular, frequently discouraged other members by quickly rejecting the

feasibility of their suggestions. Team members appeared, in general, unreceptive to the suggestions from others and everybody tried to implement their own ideas. They did not argue or fight and tried to keep a positive mood until the end of the exercises, but there was a clear lack of trust in the ideas and skills of fellow team members.

Coordination:

If there are several simultaneous tasks to be carried out and subgroups carry out these tasks, then the subgroups and their actions must be coordinated. Effective and efficient communication between subgroups, in particular, and between all members, in general, is necessary for the team to function in a coordinated manner. Moreover, a cognitive map of all members' operational positions and overall situation have to be established in each member's mind in order to provide for an overall coordination. Thus, the first team easily coordinated its actions and that speeded up the process of solving the puzzles, working through the stages of the exercise and reaching the key. The second team, on the other hand, lacked effective communication and failed to establish a shared cognitive map of the situation. Thus, they were unsuccessful in coordinating their actions. They showed impatience in their attempts to solve the puzzles, failing to ensure that they had gathered all the clues. They also jumped from one problem-solving attempt to another without recognizing that it was impossible to solve one puzzle without solving the previous one first. In the absence of a repertoire of systematic, coordinated responses, most of their actions were simply a waste of time.

3.5.2.3 Effective information gathering (situational awareness)

Resilience scholars have demonstrated the importance of being attentive to signals coming from the external environment of a team or organization. This is crucial, first, in detecting adversity and anomalies before they escalate (Meyer, 1982), and second, in collecting adequate information to formulate appropriate responses (Sutcliffe and Vogus, 2003, p. 108). In this regard, t*he first team* systematically searched for clues (first, at the very beginning of the exercise and, then, occasionally when they were out of ideas while solving a puzzle). They were also successful in spotting small details and forming associations between clues. They figured out the orientation of a Tablet PC from its position on the TV screen; they decoded the briefcase password from a picture of shapes very easily, worked out that a "black and white puzzle" meant grey and, they found out what the clue "ash" meant by remembering that books were the only thing in

the room that they had not used. They also frequently checked the TV monitor so that they were informed of any help immediately it was shown. However, they did overlook details a few times. For example, although they extensively searched the room at the beginning they missed a briefcase under a table.

The second team was not systematic regarding the detection of details or gathering of clues. They appeared rather detached from each other and acted individually while searching for clues and solutions. Since they did not try to construct a shared meaning for the clues, they lost track of the connections among them as time passed. Their increasing impatience to solve the first puzzle also made them mindless in the search for additional clues. For instance, the last clue of the first puzzle was in a drawer which was examined by all the group members individually at different times but despite this, none of them located it. Having said that, the second team did sometimes identify certain small details and associations. For example, they immediately associated the name of the author on the clue card with a book that he had written, despite acquiring the two pieces of information at very different times during the exercise. Through this, they were able to combine these two clues to reach a solution. They were also very quick to associate the "time is passing" clue with the clocks in the room and thereby obtain the code for a padlock from those clocks.

While drawing attention to the importance of *situational awareness*, resilience scholars have also warned against *overload of* information channels (Weick, Sutcliffe and Obstfeld, 2008, p. 44). Regarding this, members of *the second team* frequently disrupted the action sequences of sub groups working on other issues. The conversations below, while two sub groups were working on different clues illustrate how team members did not consider the action sequences of others:

> *Member A (from the 1st subunit, looking at a half-completed map of the room and shouting): "Looking at this, the key must be somewhere around here" (pointing towards the place where 2nd subgroup was and trying to gather their attention)*
>
> *Member B: (from the 2nd subunit, working on a different clue but distracted by the shouting of Member B towards them): "I am sorry, what?"*

Member A: (realizing only then she disturbed them): "anyways, you continue with your own work, let me not confuse you with this" (which she had already done by then)

3.5.2.4 Accumulated knowledge

The knowledge accumulated prior to the emergence of a challenge, which may be in the form of past experiences, simulations and training, has been proposed to facilitate resilience by the enlargement of skill sets (Horne and Orr, 1997, p. 32) and action repertoires (Sutcliffe and Vogus, 2003, p. 101). Even when confronted with novel challenges, entities with broader action repertories and skill sets are more likely be able to call up and combine actions that enable an effective response. In the context of Escape Games, the teams are not expected to be knowledgeable about the scenario that they face, so that the challenges are unexpected and solutions are formulated in the moment. Thus, while identifying my participants for this exploratory study, I paid attention to selecting individuals that had never been through an Escape Game before. I understood from people who had been through an escape game that those with experience would be familiar with the way exercise progresses, and would know where to look and what to do compared to others without this experience. Thus, I selected participants who had no such prior experience or training.

Nonetheless, I observed that both teams appeared to learn as the exercise progressed and hence both became quicker at finding and accurately interpreting clues. The first team in particular showed a positive learning curve, integrating each new piece of information to their knowledge base. For instance, when they received the first clue from the controller via the TV screen, it took them several minutes to notice the clue. However, after this they learned to keep an eye on the screen to make sure they obtained any extra clues the moment they appeared on the screen. The effect of learning could be expected to be even more significant if these teams conducted a second escape game exercise with a different scenario.

3.5.2.5 Improvisation

Finally, improvisation, the ability to formulate novel solutions 'in the moment' of the situation, has also been proposed by various scholars as one of the precursors of resilience (for e.g. Weick, 1993; Kendra and Wachtendorf, 2003b), and I therefore included it in my conceptual model. Selecting a setting where challenges require responses in a limited window of time by participants with no prior experience and

training, I expected to observe an association between improvisation and resilience in my exploratory study. However, there were few occasions where teams demonstrated improvisation. This may be attributable to the fact that in the escape game setting all the challenges (puzzles) and their solutions are predesigned and clearly marked by leading clues. Knowing that these clues will lead the team to the solution, the team members might have been reluctant to think 'outside the box'. What is more, trying to improvise may even be counterproductive while responding to a challenge in such a strictly predesigned setting. The reason is in such a setting, problems have unique solutions; hence, alternative interpretations of the clues and alternative solution generations may be time wasting. This may a reason why exploratory study teams were reluctant to improvise.

3.5.3 Other precursors observed to facilitate resilience

3.5.3.1 Team cohesion

In addition to the capabilities and capacities that I proposed as the precursors of resilience in my conceptual model, I have also observed the effect of certain other capabilities in my analysis of the two escape game exercises. Firstly, the cohesiveness of the teams in the form of their ability to work together in a harmonious fashion appeared to facilitate the formation of effective responses.

In the literature, team cohesion has been defined and investigated numerous times. One of the earliest definitions can be found in the study by Festinger (1950, p. 274), namely: "the resultant of all the forces acting on the members to remain in the group". This general definition was later considered on two levels: commitment to the task and commitment to the group itself (Gross and Martin, 1952). I adopted the definition by Carron (1982, p. 124), which considers both of these levels and refers to team cohesion as "a dynamic process which is reflected in the tendency for a group to stick together and remain united in the pursuit of its goals and objectives." Previous research has demonstrated the importance of cohesion for productivity (Evans and Jarvis, 1980) and performance (Kozlowski and Ilgen, 2006). Kozlowski and Ilgen (2006, p. 89) concluded that cohesion is more significant for teams when "team workflow demands increase interdependence and require greater coordination of information and effort.", which is the case when teams are operating in challenging conditions.

In my exploratory study, in both teams, the members were all studying or working in the same group (the first team members had been studying in the same PhD

programme for six months and the members of the second team had been working in the same business school for two years), so in both teams, team members personally knew each other. The first team had never worked as a team prior to the exercise; on the other hand, as colleagues from the same department, the second team worked as a group on work-related projects before. Knowing this, I expected the first team to take some time to establish a cohesive group atmosphere and the second team to establish cohesion in the first few minutes of the exercise. Surprisingly, the reality was contrary to my expectations.

From the initial moments, the first team was committed to completing the exercise and unified as a single entity for this purpose. While brainstorming, they always framed the discussion as "how can each one of us contribute to achieve our ultimate purpose?" Two members appeared to wish to lead the group actions, however, instead of fighting over the leadership they mutually managed the team in two subunits with constant communication between them. For the majority of the exercise, the team operated in two subunits and the subunits merged into a single entity when brainstorming was needed or when the task required more capacity (e.g. the Greek letter encryption).

In the second team, as mentioned above, the individuals tended to act alone throughout the exercise. This was particularly observable in terms of their inability to combine pieces of information together. There was a handful of instances in which members tried to establish cohesion and enable collective action, however, these were not very effective. For instance, while working on the first puzzle, they gathered all the clues, however, they were unable to interpret them immediately. This led some members' attention to be diverted to other items in the room. Members made comments such as "there is something with these clues, come on, please focus on this", "come on, let's do group effort", but these were not very effective in getting the distracted members' attention back to solving the first puzzle. Moreover, no one tried to establish a holistic way of looking at the situation and no one shared their findings to the group in an organized way. Interestingly, they were aware of this problem and some members individually called others to establish group norms and work as a team. For instance, in the first half of the exercise, a member explicitly stated: "we are not working as a team", and another member agreed: "yes, let's gather together, come on!" In another instance, while the group was trying to solve a specific puzzle, members started to dissolve and act independently. To warn them, a member called others by their names and said: "I

think we should focus here first!" Unfortunately, almost none of these attempts succeeded in gathering the group together and establishing cohesive action.

In the resilience literature, there are conceptual as well as empirical studies that propose a relationship between cohesiveness and resilience. For instance, Lengnick-Hall and Beck (2005, p. 750) and Horne and Orr (1997, p. 32) suggested that when the members of an entity are united under a *core identity* or a *common purpose*, they are motivated and directed towards achieving common goals and eliminating challenges that stand in the way of hem achieving these goals. Moreover, in their investigation of sports teams, Morgan *et al.* (2013, p. 556) found a relationship between team cohesion and team resilience. In the light of this, I decided to add *team cohesion* to my research model among the precursors of resilience.

3.5.3.2 Team Potency (Collective efficacy)

Another significant difference between the first team and the second team that I observed was in their belief in the team's potential to complete the exercise in 60 minutes. Along with their unification under the common purpose of completing the exercise, the members of the first team also had a strong belief in their success. During the pre-exercise discussion, they constantly regarded their team as a team of capable and competent individuals with strong ambition. Moreover, although they had a slow start, they never voiced any concern about whether this might prevent them from reaching the key.

On the other hand, the second team was quite anxious before going into the exercise. They made jokes about how they would like to keep the video-recording secret if they could not complete the exercise. In the exercise, the slow solution to the first puzzle was linked to members' inability to establish effective communication. This made team members demotivated, anxious, pessimistic and insecure from time to time. Group members constantly uttered phrases like "I am bored!", "I feel we are not going to be able to finish this.", "We were so slow in doing…" This insecurity was especially noticeable in their behaviour in the latter part of the exercise: they frequently came up with different ideas to solve the puzzles but they did not think them worth trying and even those who generated the ideas appeared reluctant to try them. This may also be a sign of their lack of confidence in their own ideas and capabilities.

In the literature, the confidence in a team's own ideas and capabilities is labelled as 'team potency' and 'team efficacy' (Kozlowski and Ilgen, 2006). Self-efficacy was

initially defined at the individual level by Bandura (1977, p. 193) in the form of one's expectation with regard to the fact that s/he "can successfully execute the behavio[u]r required to produce the outcomes." Self-efficacy is proposed to contribute to performance based on the logic that the strength of people's belief in their capacity to achieve might stimulate them to set higher goals and to actually achieve higher levels of performance (Phillips, Hollenbeck and Ilgen, 1996). Self-efficacy has also been defined at the team level (Lindsley, Brass and Thomas, 1995, p. 648) as: "the group's (or organization's) collective belief that it can successfully perform a specific task." and labelled as *collective efficacy*. Feltz and Lirgg (1998, p. 558) suggest that collective efficacy is different from the mere aggregation of self-efficacy of team members in the sense that it is a 'shared' attribute and hence degree of consensus should be considered when measuring it.

Another construct, regarded as very similar according to many researchers in the field, is *team* or *group potency*, and defined as (Shea and Guzzo, 1987, p. 335): "the collective belief of a group that it can be effective." Kozlowski and Ilgen (2006) asserted the subtle difference between *team potency* and *collective efficacy* as generality and specificity. According to these authors, collective efficacy is "task specific", whereas team potency is about "general effectiveness". Adopting this view, I included this dynamic as *team potency* in my conceptual model, as a general indicator of teams' belief in their capabilities to overcome challenges and increase performance.

In the general teams literature, both team potency and collective efficacy are found to contribute to performance (Gully *et al.*, 2002). In the literature specific to resilience, regarding collective efficacy / team potency, Sutcliffe and Vogus (2003, p. 102) proposed that groups may be resilient to challenges in their operating environments if members collectively believe in the capabilities of the group. In their quantitative investigation of 194 teams, Vera *et al.* (2017, p. 128) found strong and meaningful positive relationship between *collective efficacy* and *team resilience*. Considering these findings and my own observations from the exploratory study, I decided to add *collective efficacy* in my research model.

3.5.3.3 Collective Mindfulness:

Based on my analysis, I also found Weick *et al.*'s (2008) 'mindfulness' concept, which they define as a capability that "induce[s] a rich awareness of discriminatory detail and a capacity for action" (Weick, Sutcliffe and Obstfeld, 2008, p. 37), relevant to

establishing *collective mental models* and achieving *resilience*. By openly talking about solution ideas, by establishing the complete picture of the operations, by being attentive to the hidden details in clues and by allowing tasks to be performed by the members that have the relevant competence, entities can manage unknown situations, such as the puzzles in the escape game context. To be able to provide this capacity, entities need to demonstrate these characteristics. These characteristics were observable in the first team as they were attentive to the details, they were discussing and evaluating all the alternative solutions and they successfully established the cognitive map of the situation they were in. As a result of mindful acting, they demonstrated a good balance of persistence and retreat. They generally did not persist in continuing unsuccessful attempts, they did not insist on trying impossible ideas but they did give a shot to many ideas (some of which were not very likely) without premature judgement. They also provided a good balance between attentiveness (to recognize details) and comprehension (to complete the cognitive map).

The second team was frequently observed as behaving mindlessly; for instance, while searching for clues they searched the very same places several times or while generating possible solutions to the puzzles they came up with the right ideas but they did not evaluate them properly. They were generally caught up too much in the details and were not be very successful in balancing this with the comprehension afforded by the big picture. A partial reason for this problem was their inability to establish effective communication among themselves. They tended to preserve with blind alleys rather than re-assessing the situation. For e.g. they insisted on using the transparent decoding sheets all together and getting the whole code at once in the first puzzle, whereas what they needed to do was to separately examine the sheets and extract individual numbers of the code from each sheet. In another example, they needed to figure out the written version of a numerical code (e.g. “thirteen” would mean that the code is “13”) in the page-line-letter coding, but instead they insisted on trying to find numbers from the book. This was impossible with the clue they had, so they tried to use the clue in several overcomplex ways in order to extract any number, but all their attempts were unsuccessful.

Conclusively, according to my exploratory study, the factors that contribute to the resilience of organizations in high-risk industries to the challenges of their operational environment (which is discussed in detail in section 2.3.1) may also contribute to the resilience to challenges in non-extreme operational environments. Therefore, I decided

to include *collective mindfulness* in my research model, among the team dynamics that contribute to resilience. In my framework, I modelled this concept as an indicator of *collective mental models* along with *transactive memory systems.*

3.5.4 Resilience and team performance

Finally, through this exploratory study, I also wanted to investigate the relationship between resilience and performance. As I mentioned in section 2.5.2, for many resilience scholars, performance is seen as the outcome of being resilient in the face of challenges in the operational environment (Lengnick-Hall and Beck, 2005; e.g. Sheffi, 2005), particularly for organizational settings where survival is not threatened. As I aim to establish a resilience framework for such settings, I identified the outcome of resilience as *operational performance* in my model.

In the context of escape game settings, I operationalized this outcome as the "time spent to complete the exercise". The first team completed the exercise in 48 minutes and the second team was unable to complete it within the 60 minutes allowed. Considering my analysis above, I concluded that the first team was resilient to the challenges of the exercise, which was reflected in the outcome. This team was able to quickly and efficiently address the problems they faced and come up with the solutions to overcome these problems. With a similar logic, the second team experienced problems in demonstrating the skills to respond to challenges, and in turn, was reflected in their performance. However, while analysing the performance in my exploratory study, I realized that it was synonymous with responding the challenges, as responding to and overcoming challenges made the teams obtain the key. Differently, in the context of real-life entities, performance is perhaps better defined as the ability to achieve organizational purposes (whether or not there are challenges); and challenges disrupt entities while they work on the activities necessary to achieve these purposes. Such a collective purpose (other than responding to the challenges) did not exist in the escape game settings, which in a sense represent problem-solving activities for their own sake, as a form of entertainment. Therefore, although confirming my conceptual model, I decided that escape game settings were not the ideal settings to investigate the relationship between resilience and performance.

3.6 Conclusion

I conducted this exploratory study with three aims: to investigate my conceptual framework, to understand the advantages and limitations associated with conducting resilience research in an artificial setting; and to try out the escape game setting as a research environment. With regards to the first aim, as a result of my analysis of this exploratory study, I improved my research model to the version illustrated in Figure 6. The analysis provided some qualitative validation of the relationship between *collective mental models* and *resilience*. To operationalize *collective mental models*, I decided to use the *transactive memory systems* framework by Lewis (2003) and the *(collective) mindfulness* framework by Weick *et al.* (2008). Moreover, *effective communication* and *information gathering systems* were also found to be related to resilience. *Accumulated knowledge* and *improvisation* could not be observed in this study, but I suspected that this was due to the limitations of the research setting and decided to continue to include them in the framework. Finally, two more constructs, namely *team cohesion* and *collective efficacy/potency* have been shown to affect team resilience and performance, both in the exploratory study and in previous literature. I therefore decided to add them among the precursors of resilience. Moreover, my analysis in the exploratory study implied the relationship between resilience and performance, so this relationship is included in the framework. However, performance is re-defined in way to highlight its relations with the main purposes of the entity.

With regards to the second purpose, this study demonstrated that using an artificial setting can be advantageous in terms of observing team responses to challenges. As I mentioned before, one of the biggest methodological challenges with resilience research is the need for, but the difficulty of, real time data collection. It is needed, because post-hoc data collection may not reveal the mechanisms that lead to resilience; and it is often based on testimonials and so, may be affected by the self-report bias (Alesch *et al.*, 2001, p. 42). On the other hand, real-time data collection is difficult, because it is not feasible and effective to collect data while people are responding to possibly serious and consequential challenges. In an artificial setting, participants will not be disturbed as much since the challenges do not have huge consequences; and an artificial setting may allow designs of data collection that do not disrupt participants while they confront challenges. Moreover, the data may be collected in real time, so it is less unlikely that participants create their own narratives (versions of the incident) which are then reproduced in research interviews.

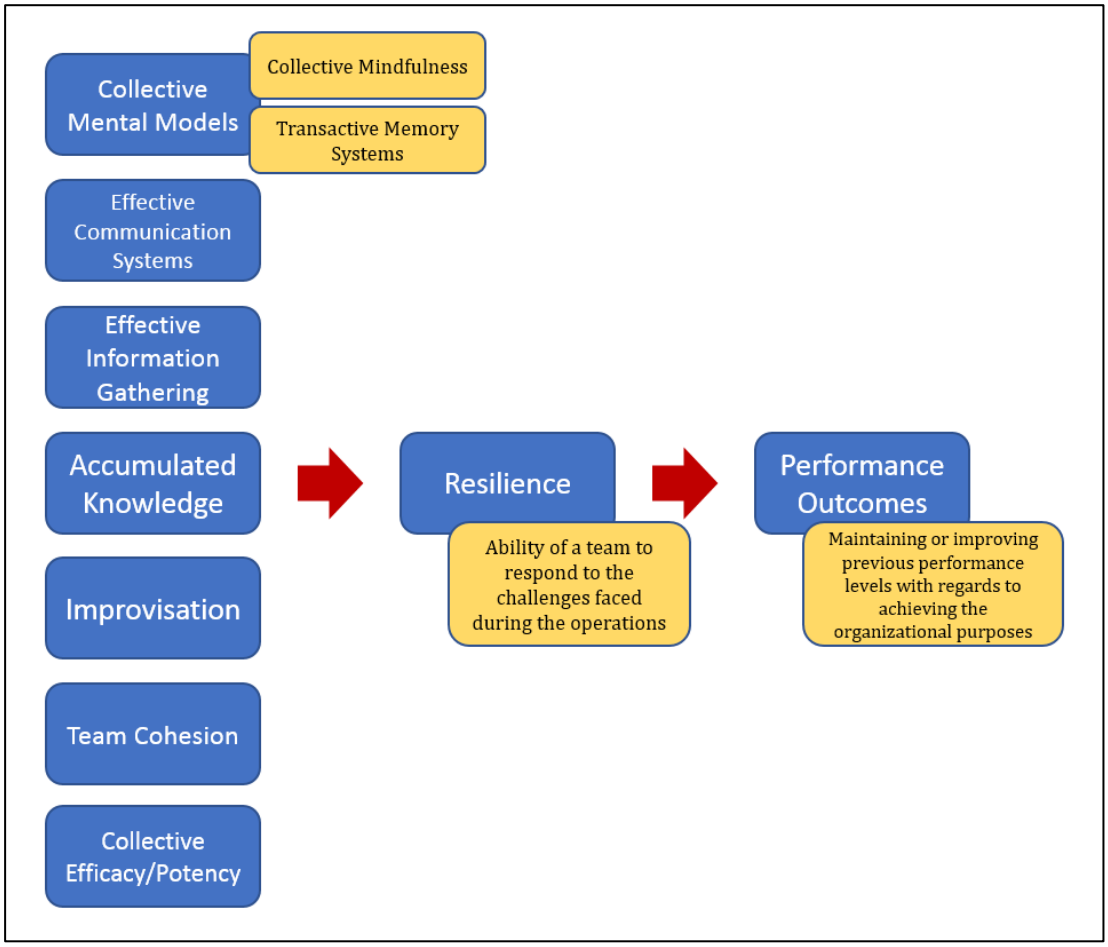

Figure 6. Improved research model

However, obviously there are disadvantages associated with conducting resilience research in an artificial setting. In an artificial setting, the challenges are (almost) non-consequential in terms of their effects to the real life. No negative outcomes are likely to come out of them except perhaps a 'feeling of failure'. This feeling, by itself, creates a significant amount of stress and anxiety as supported by the testimonials of the participants, however, this effect is not expected to be equal to the effect of a real-life challenge with real-life consequences. Thus, with the stress and anxiety caused by real-life challenges, teams' responses to the challenges might be different to that which is observed in an artificial setting. This disadvantage was particularly valid for the escape game settings. In spite of their challenging nature, escape games are designed as an amusement activity; and all the challenges in the setting are strictly pre-structured. In real life, far less can be controlled when it comes to challenges and to responses to

them. Hence, in my main study, I decide to use a setting where challenges occur in a more naturalistic/realistic manner, but where some control and direct observation was also possible.

Another problem associated with escape game setting was the operationalization of the performance. As I mentioned in section 3.5.4, in real life, entities, such as teams and organizations, have purposes and they act to accomplish these purposes. The challenges they face disrupt their actions; and hence, the outcome of being resilient to challenges is reflected in performance with regards to accomplishing these purposes. In escape game settings, the entities (teams) do not have such collective purposes other than responding to the challenges – in this case, solving puzzles. Thus, the only way to operationalize the outcomes of resilience is to measure how quickly they complete the challenges. Considering this, in my main study, I decided to use a setting where entities would have purposes other than responding to the challenges and the levels of performance in achieving this purpose can be operationalizable as outcomes of resilience.

In the following chapter, I explain the design and the methods of my main study. I demonstrate and justify my choices with regard to the setting, the participants, and the data collection and analysis methods, and, then, I present the operationalized version of my research model along with the hypotheses I tested with the main study analysis.

4 Main Study: Methodology

4.1 Introduction

In this study, I aim to investigate resilience by introducing a method novel to the field: simulation. In order to do that, first, I conducted a thorough literature analysis and provided its details in the second chapter. As a result of this analysis, I established a research model and conducted an initial trial of this with an exploratory study. Details of this exploratory were provided in chapter three. Both literature analysis and exploratory study helped me in deciding the methods to be used in the main study. In this fourth chapter, I describe the data collection and analysis methods I used to conduct the main study. I provide the details of main study research design, the simulation method, various data collections methods employed, and lastly, tools and software I used to analyse this data along with the procedures I followed.

The main part of this research was conducted as a part of a bigger project in which a research team including myself and four other researchers work to identify the team attributes and processes that facilitate performance in fast-paced, competitive and disruptive market conditions. In order to investigate this, fast-paced market conditions were simulated, in which teams of 6-10 people needed to perform a moderately complex set of operations quickly and accurately in a turbulent, competitive environment. Various data collection methods were used to collect the data I used to test my research model and the hypotheses that I had formulated. My main study is based on data from seven separate runs of the simulation over three years, covering a total of 68 teams and 547 participants (from which complete questionnaire data were obtained from 541 participants). Using these data, I investigate the factors contributing to the team resilience and the relationship between team resilience and team performance.

Both qualitative and quantitative data were collected; hence, I have adopted mixed methods approach to conduct the analysis. I have used a convergent parallel mixed methods model, in which both qualitative and quantitative data have been collected at the same time and used together to conduct the analysis and interpret the results (Creswell, 2014, p. 15). I have conducted quantitative analysis methods to test various relationships in my model, and, then, using qualitative data, I elaborated on the mechanisms of the relationships tested with quantitative analysis. I also used

qualitative data to explore the relationships that I could not test with quantitative analysis.

4.2 Research Design

4.2.1 Methodological choices

As I mentioned in section 2.4, one of the most important problems of the organizational resilience literature is the lack of diversity in methodological choices. First, the field is dominated by case studies using post-hoc and self-report data (Bhamra, Dani and Burnard, 2011; Linnenluecke, 2017). In these studies, researchers could not collect data about the challenge-response processes themselves; and so, they based their analysis on the testimonials they gather from the people who experienced the challenge, in most cases, a long time ago. Unfortunately, people tend to forget or, worse, reconstruct the past. Therefore, this work may be limited in its ability to capture information about the processes that explain how certain factors are effective in the manifestation of resilience and how resilience in turn affects individual and collective outcomes.

Second, a majority of the work investigates resilience-related issues in extreme settings. Hence, the literature is abundant in making propositions about the factors that lead to resilience when operating in high-risk conditions or when faced with natural disasters, high-impact human errors and political, technological or economic disruptions. However, these findings are not always meaningful for organizations that desire to improve their resilience in the face of lower-impact, but more frequent perturbations in their daily operations. The process of formulating responses to less extreme challenges may be different, as these challenges are faced more frequently, apply to smaller units, and are mainly focused on operational performance as opposed to survival. Thus, the results of these studies may not be generalizable to wider populations of organizations that whose resilience is tested by a stream of daily challenges.

Lastly, in investigations of organizational resilience, information is generally captured at a single point in time, which, again, can be problematic in terms of analysing the challenge-response process. Since researchers do not capture data throughout the entirety of this process, the mechanisms of resilience and its outcomes may not be

effectively revealed. In addition, if information is only gathered about a single challenge-response process, then the effects of accumulated knowledge, past experience and learning cannot be analysed. Therefore, previous work is also limited in terms of demonstrating the mechanisms of resilience and the effects of experiencing prior challenges on resilience to future challenges.

The methodological choices that I made in this study sought to address these limitations. The first important choice I had to make was about the *unit of analysis*. In this study, I wanted to investigate the relationship between collective dynamics and collective resilience. Thus, I could not identify individuals as the unit of analysis as it would prevent me from capturing data about collective capacities and capabilities. Analysis at the level of the whole organization could have provided a rich understanding of how capacities and actions at different levels (individual, team and organizational) form and intermingle in the development of resilient responses (e.g. Freeman, Hirschhorn and Triad, 2003b; Jaaron and Backhouse, 2014). However, it is highly demanding (time-wise and budget-wise) to design a study with a large sample of organizations and achieving comparability can be difficult. This may be one reason why almost all of the studies at the organizational level are in case study format, investigating either one or two organizations. This creates a generalizability problem with respect to the results obtained (Linnenluecke, 2017, p. 15). I therefore chose teams as the unit of analysis because "teams" appeared to allow investigation of the effects of collective capacities without sacrificing comparability and generalizability. This allowed me to design a study of resilience with a relatively large sample within a reasonable budget. Employing such a design, I was able to conduct quantitative analysis to yield generalizable results. However, I acknowledge the fact that organizations and teams are not synonymous; most organizations are larger collective entities that have more levels of nested structures and processes. Therefore, applying the results gathered in this study in organizations might not be straightforward.

A second consideration was the type of research setting: whether to use a real setting or an artificial setting. In a real setting, challenges have real consequences for the entities investigated. This is advantageous because participants' reactions to challenges will be more authentic compared to an artificial setting. Furthermore, it is impossible to perfectly mimic real conditions in an artificial setting, however hard researchers try to replicate real conditions. This may mean that certain conditions which might influence resilience cannot effectively be simulated in an artificial setting. Considering these

issues, I first thought about doing my research in a real setting. I searched for organizations in fast-paced market conditions, in which operations are frequently disrupted by unexpected challenges and rapid changes; hence, resilience to these challenges is significant in maintaining the levels of operational performance. As a result of this search, I met with teams in technologically or economically volatile market conditions (such as app developers and start-up firms). In these meetings, I have realised the disadvantages of doing a real-time resilience research in real settings. It would be impossible to schedule real-time data collection activities as I would never know when the participants would face challenges. Moreover, participants might be disturbed by my data collection activities while they were responding to the challenges with real consequences. Hence, to be able to properly collect real time data on challenge-response process, I chose an artificial setting.

In the chosen setting teams of 6-10 participants were subjected to challenges. Data were collected with regard to how the teams approached the challenges, how resilient they were in responding and how they ultimately performed. This allowed for detailed recording and analysis of the behavioural and environmental dynamics that affected the challenge-response process and for comparison between multiple units with respect to the concepts investigated in this study. This methodology is crucial in terms of bringing novelty to the investigation of resilience. There have been agent-based simulations or scenario-based approaches (where scenarios such as terrorist attacks or natural disasters) –in both of which computers or humans work on solving specific disruption scenarios– but these have been applied in a limited way (Cumming *et al.*, 2005; Datta, 2007). For instance, while simulating a natural disaster, since an actual disaster cannot be replicated, participants can only be briefed with written documents and this does not provide a "real" challenge sense for participants. Hence, these methodologies do not permit observation and analysis of the cognitive and behavioural processes of individuals and groups that emerge in an actual challenging condition. Of course, it is extremely hard to design such settings where participants feel as stressed as they would in a real challenging environment of any kind. However, by putting participants into challenging operational conditions rather than giving them scenarios to work on, this study aimed to obtain results as close as possible to those of real, challenging conditions. In order to check this, participants were asked to rate themselves with regard to certain feelings such as tenseness. This choice strengthens the validity of the results of this study.

Lastly, I faced the choice of whether to use qualitative or quantitative methods to collect the data and conduct the analysis. In order to strengthen the generalizability of the results, I planned to work with a relatively large sample and utilize quantitative analysis methods. In order to be able to reveal and test the patterns in the data, I needed to run statistical tests. However, to be able to address the problem of the lack of understanding with regards to the mechanisms behind these patterns, I also needed to search for the explanations of these patterns. This was only possible by collecting qualitative data on the critical incidents and by analysing them in combination with the patterns discovered by statistical tests. Consequently, I have decided to exploit both methods. Following the methodological roadmap suggested by Turner *et al.* (2015, pp. 14–17), I decided to employ **convergent and holistic triangulation**, where I used quantitative data to test the theory and qualitative data to illustrate and where possible explain some of the patterns seen in the quantitative data. In other words, I used quantitative methods to systematically test hypotheses with regards to the likely relationships based on the previous literature and on my observations from my exploratory study. I used qualitative data to enrich the interpretation of the quantitative data and to seek insights that could not easily be revealed by the quantitative data.

4.2.2 Participants

As mentioned earlier, this study forms part of a more substantial project into team resilience and performance conducted at the University of Edinburgh Business School. This project has an educational aspect to it; the participants of the project, and hence, of this study, are students who take the post-graduate level courses that utilize the simulation. These courses are run once a year, thus, each year a new set of participants are included in the data. Each student participates in one simulation only.

For many years, the simulation has only been run for educational purposes. Its use as a setting for research into team resilience began in 2015 and has been continuing for three consecutive academic years so far. The courses in which the simulation was utilized were given at the MBA, MSc and E-MBA levels. Over the course of three years, 547 participants from these programmes participated in the simulation. Participants were randomly (within their programme and within their education year) allocated to teams of 6 to 10 members, resulting in 68 teams.

One might question conducting statistical analysis with this sample since it is not selected using probability sampling procedures. However, as Vehovar *et al.* (2017) explained in their work, non-probability samples are 'naturally' randomized, and hence, use of statistical inferencing is deemed acceptable by many scholars. In addition, the sample in this research is adequately diverse in the sense that there are participants coming from various demographic and organizational backgrounds. There are people from 72 different nationalities belonging to different age groups, with different levels of work experiences, who either worked or were still working in different industries and sectors. Thus, results of the study may be generalizable to teams operating at various sectors and industries in various countries.

4.3 An overview of the Simulation

4.3.1 Simulation Process

The data of this study comes from seven runs of the simulation conducted over a three-year period. In the simulation, a "trading period" takes place, where the conditions of a fast-paced greetings cards market are replicated. In this "trading period" teams act as companies producing greetings cards and competing to be the most profitable company in the market by securing orders from a marketplace and actually producing batches of greetings cards. This requires participants to work in their teams in a tightly coordinated fashion while simultaneously dealing with various operational challenges such as environmental disturbance (noise, low lightening, shaking production tables, etc.), inventory problems, or rejections of delivered orders or intra-team conflicts. Table 3 provides the details of the seven runs of the simulation. The process of the simulation is detailed below.

4.3.1.1 Preparation and Planning

Four weeks prior to the commencement of the "trading period", researchers brief controllers and participants to explain the simulation rules and procedures. A team of controllers ran each simulation; the controllers were staff and PhD students from the University of Edinburgh Business School. I acted as a controller in all seven runs of the simulation. Approximately one controller is required per 10-12 participants (one per 1-1.5 teams) to run the simulation. Controllers undertake one of three roles: administration, responsible for overall monitoring and data processing; quality control, responsible for issuing orders, inspecting the accuracy of the completed and submitted

orders and paying the teams for successful orders; and procurement, responsible for supplying materials and equipment to the teams during the trading period.

No.	Date and Time	Programme	No of participants	No of teams
1	19 October 2015 14:30-16:45	MBA	44	6
2	23 October 2015 14:00-16:15	MSc	121	15
3	17 October 2015 14:00-16:15	MBA	43	6
4	21 October 2016 14:00-16:15	MSc	139	16
5	10 March 2017 14:30-16:45	EMBA	28	4
6	16 October 2017 14:00-16:15	MBA	48	6
7	20 October 2017 14:00-16:15	MSc	124	15
			547	68

Table 3. Details of the seven runs of the simulation

After been given the brief participants are allocated into the teams. These allocations are random. Which students participate in a specific simulation is determined by the programme on which they are enrolled (MBA, MSc or EMBA). The simulation is an integral part of a course on Organizational Behaviour. For MBA and EMBA programmes, all students take this course and therefore random team allocations are made within these complete groups of students. The MSc Organizational Behaviour course is shared by students from four different MSc programmes, namely Management, Human Resource Management (HRM), International Business and Emerging Markets (IBEM) and International Human Resource Management (IHRM). Thus, for the MSc programmes, random team allocations are made within the specific programme. In other words, MSc Management students are teamed up among themselves, and so on.

Further to the allocations, teams start preparing for the trading day. They have around four weeks in which to do this. In this time, they get to know each other as the exercise is run at the start of the academic year and is the first major team exercise that the students undertake and establish team norms; develop strategies in line with the nature of the trading period as well as the particularities of their team; and decide the

most efficient ways to achieve their strategies. This process includes identifying team and member strengths and weaknesses, organizing the team around these and allocating specific tasks accordingly. The nature of these tasks depends on the specific roles adopted. For operational and managerial activities, formulating strategies, conducting scenario analyses, forming alternative plans and contingencies, and running and validating financial analyses are among the central tasks. Production workers, on the other hand, are responsible meeting the specific production requirements. Members coordinate throughout the preparation stage to ensure compatibility between strategy and execution. No strategy will work in the trading period if it cannot be executed. For instance, the most profitable orders require 12 greetings cards to be produced in 15 minutes. If the production unit is not fast enough to complete 12 cards accurately in 15 minutes, the most reasonable strategy for this team might be to avoid this type of order. In order to make sure the subunits of a team can work in a well-coordinated fashion teams may conduct mock trading periods and see if the strategies and execution are in line. However, no matter how well they conduct these mock trading periods, it is difficult to imitate the exact conditions of the trading day.

Within the week before the trading takes place, controllers allocate the material (e.g. paper sheets), the equipment (e.g. pen, rulers, stencils) and the cash pre-ordered by the teams. A starter pack including a standard set of materials and equipment was provided for the first four runs of the simulation. The teams receive these materials in team boxes. In these boxes, four additional documents are provided: a document detailing the general specifications with regards to the product (greetings cards), a final accounts form for them to calculate the value of the cash, material and equipment they left unused at the end; emergency loan forms if they become short of cash during the trading period (for which the interest rate is 25%); and procurement forms for them to be able to order materials and equipment during the trading period. Examples of these documents can be found in Appendix - 10.3.

4.3.1.2 Trading day

On trading day, participants and controllers take their places in the trading room. The Controllers' area has three sections. First, quality control tables are located near to the order board. Quality controllers also issue orders to the teams and hence they have to be close to the order board. The order board is filled with the orders before the trading period. For the small-scale runs of the simulation (4-6 teams), there are around 10-12 orders at once on the order boards, but this number increases to 20 for the large-scale

runs of the simulation (15+ teams). Behind the quality control tables, there are boxes for accepted and rejected order forms, accepted cards (as rejected cards are returned to the teams) and envelopes (orders are delivered in envelopes). Accepted and rejected order forms are used to enter data on team performance. Second, there, there is a procurement station, which has a stock of equipment and materials that the teams can purchase during the trading period. Lastly, on the back, there is a station administration and data processing as trading progresses.

Right before the trading period begins, the lead controller gives an introductory speech outlining the schedule for the next few hours and answering any final questions. Then, he rings a loud bell to signal the start. The first 10-15 minutes of the trading period are extremely chaotic, particularly for the large-scale runs of the simulation. Team order-takers descend upon the order board and yell the order numbers at the controllers to get the order they desire. Controllers need to quickly issue orders and replenish the order board as the initial orders are issued to the teams. After the initial frenzy, teams start producing and the atmosphere calms down. After that point, the level of turbulence (in the form of participants running around and shouting) goes up and down in line with the production cycles of the teams.

During the trading period, teams operate in production cycles. Order takers examine the order board and try to identify the order(s) that match the strategies of their teams. Order-takers may need to consult with the team's stock controller to make sure there are enough materials to produce the order. Once the order is decided, order takers ask one of the controllers to issue that order to his/her team. The order taker, then, takes the Sales Order and Delivery Notice (SODN) sheet, on which the details of the order are written (an example is shown in Appendix - 10.4), to the team table and the production members of the team start producing it. The SODN indicates the specific product requirements: occasion (wedding, Christmas, birthday, anniversary, birthday, etc.), number or cards (4, 8 or 12), colour (white, blue, green, pink, yellow or salmon), size (A5, A6 or A7), number of lines of verse (2, 4 or 6), time allowed (15 minutes, 20 minutes, 25 minutes, 30 minutes or open-ended), and the price (which varies between £150 and £1250 in accordance with the difficulty of the order). Considering these variations, there are potentially nearly 30,000 different types of orders that can appear on the order board, which creates high levels of uncertainty. Hence, teams need to do rigorous strategizing to be able to identify and secure their desired types of orders.

Teams vary in terms of how they organize production. A typical approach is for the necessary materials (sheets of the right colour and an envelope) to be arranged first. Then, since all sheets are given in A4 size, folding is done in accordance with the required size. Following the fold, on the front of the cards, the occasion is stencilled centrally (10mm stencil if an A5 or A6 card, 5mm stencil if A6 or A7). On the inside, the verse is handwritten within a pre-specified margin, and on the back, team ID and order number are written in the bottom right corner (e.g. Co-A/SO1). When the order is complete and the team is satisfied with the quality, cards are put into the envelope, and the envelope labelled with the team ID and order number. All the equipment to produce the cards (pen, stencils, rulers, pencils, etc.) must be bought from the controllers. This rule is strictly enforced.

Completed orders are delivered to a Quality Controller. The controller first checks whether the deadline is met. If not, the order is qualified as a late delivery and in addition to no payment, the team will be fined 20% of the order price. If the deadline is met, then the cards are checked against the general specification (such as accurate margins and centralization, rhyming verses, no smudging or marks, etc.) and the order's specific demands (such as number of cards, colour, occasion, etc.). If all the criteria are met, then the order sheet is marked as an 'accept', the product is taken from the team and the team is paid the price with (fake) cash. If not, then team is informed of the rejection (by a loud whistle to create an unfavourable atmosphere for that team and to worry the rest) and the rejected cards are returned to the team.

An important element of the production cycle is stock control as teams need to have the necessary equipment and materials to produce an order. Although teams pre-order equipment and materials before the trading period, pre-ordered stock is generally inadequate for the whole duration of the trading period, and so teams buy more as trading progresses. For these purchases, they fill in a procurement form and take it to the procurement desk along with the cash required to complete the transaction and the materials box (simulating a transportation container). Procurement also has a lead time which is announced before the beginning of the trading period. This was 10 minutes for the first five runs of the simulation and lowered to 5 minutes for the last two, as the absence of a starter pack was produced to create additional inventory control, issues). Within this lead-time, the procurement controllers take the procurement form and payment, fill the materials box with the ordered materials and equipment and then hold the box until the lead time has elapsed. In addition to buying

materials from the official procurement station, teams are also allowed to trade between each other on whatever terms they agree amongst themselves.

Teams have to make many rapid decisions using information from various sources acquired by different team members. Hence collective mental models are likely to be important to their overall resilience and performance during the trading period. Moreover, decisions have to be implemented by different members working on the different tasks, which means cohesion and intra-team communication are also key. Lastly, teams face unexpected adversities throughout the trading period; hence, broad action repertoires and an ability to collectively improvise are required to help them address and overcome challenges and maintain performance levels.

4.3.1.3 Post-Trading

Once trading is finished, participants immediately complete the post-trading questionnaire and then spend about an hour reflecting collectively on what happened during the trading period whilst the Controllers' calculate some basic performance data. After about an hour the controllers announce the preliminary results in terms of cards per head, rejects and profit or loss and, in the smaller simulations there is a brief open discussion of the results. In all cases this is followed by an informal social event for participants and controllers.

In the day following the trading period, data from the pre- and the post-trading questionnaires and from the performance indicators are processed into a database using SPSS Software. Once all the data is in, an initial analysis generates some descriptive statistics which are used to provide information to the participants for them to use for their presentations and reflective assignments.

Teams are required to make presentations on their performance one or two weeks after the trading period. For these presentations, they are provided with validated, double-checked results (including data on profits, value of sales, reject rate and average value per order for all the teams participating in that simulation) and the aforementioned 'initial analysis' of the data from pre- and post-trading questionnaires. In addition to this information, they also draw on their collective experience of the simulation as the base for their presentation. In these presentations, they compare their prior expectations with reality; they identify the strengths and weaknesses associated with their performance; and they demonstrate what they have learned as a

result of this experience. These presentations are primarily educational, but they also provide useful data on the activities of each team for research purposes.

4.3.2 The rationale behind choosing "greetings cards market" simulation to investigate resilience

The simulation was initially designed as a teaching exercise, long before it is used as a research method for this project. The simulation requires teams to interpret their environments, think, decide and act quickly, at least faster than the competition, and adapt to the changing conditions of the market (for e.g. rapidly changing types of orders on the order board) and the actions of competitors (for e.g. if two competing teams are going after the same type of order). In order to perform satisfactorily, teams need to address challenges (such as rejections, inventory problems, intra-team conflicts, an inconvenient operation environment, etc.) while maintaining their production quality and speed. This requires them to be attentive to weak signals of forthcoming problems and to constantly update the collective conceptual map of internal and external operational dynamics.

In addition to this dynamism, there are many adversities the teams have to deal with throughout the trading period. The challenges start with the formation of teams where people who don't know each other have to work together in a coordinated fashion. The trading period atmosphere is extremely disturbing and noisy (especially for large-scale runs of the simulation) with many teams actively seeking the best performance results. There is constant communication between team members, between competing teams and between teams and controllers and this creates a lot of noise. There is also constant shuttling between team tables and the Controllers' area (for the purposes of order getting, order submission and procurement) which is one of the biggest causes of disruption for those engaged in production.

Moreover, there are also operational and performance related adversities, which are frequently mentioned as reasons for disruption by the participants. First of all, teams often experience shock when they realize the trading period is not as they have expected and their plans are not going to work as the way they imagined. No matter how intensively teams try to imitate the trading period during their preparation, they can never precisely anticipate the conditions that they will face. Thus, they are faced with orders incompatible to their strategies on the order board or lengthening queues in front of the controller tables, so they are forced to adapt. Secondly, they are also

challenged by the need to manage the production cycle and maintain stock levels for 135 minutes. Order takers have to monitor the order board and get the optimum orders (most profitable ones that the team can manage to accurately produce within the deadline), stock controllers have to always make sure there is enough stock for these orders and take the procurement lead time (and possible procurement queues) into consideration. Production sub-units have to be motivated to produce for the whole duration without any collapse. Specialist functions need to be in constant communication and close coordination. Any error in this cycle has the potential to drag the team into a crisis (for e.g. orders taken without the adequate stock necessary materials). Thirdly, teams experience adversity most explicitly when they cannot not meet the deadline with the order they produced and submitted, or when the order is rejected by the controllers, as these events have direct negative effect on performance. Rejected and unfulfilled orders destroy prior performance projections, and cause loss of motivation within the teams. Rejections may also be a consequence of a false interpretation of the general product specifications which may require a team to reorganize its production cycle (for e.g. in the form of changing the type of target orders or changing the roles within the team). All these conditions require teams to demonstrate resilience, adapt to the newly understood conditions and continue operating in the face of disruption.

4.4 Data Collection Methods

As mentioned above, I utilized quantitative methods to test several relationships in my research model. Therefore, I used the data collected by tools that allowed systematic and structured data accumulation. I then processed this data into an SPSS database and ran the necessary statistical analyses. However, while interpreting the results of these analyses, I also benefited from additional rich information about specific incidences and processes that occurred during the simulation; particularly to explain and give context to some of relationships revealed. This additional rich information was collected by qualitative data collection tools, which collected data less systematically but in a more detailed and descriptive manner. I also used this data to explore the relationships in my model that I could not test with quantitative analysis. All the quantitative and qualitative data collection methods utilized in this study are explained below.

4.4.1 Questionnaires

A questionnaire is a method of survey research, which aims to systematically collect data from a range of participants (Julien, 2008). The questionnaire method is amongst the most preferred data collection methods in social research (Oliver, 2010). It is also termed a "self-completion questionnaire" (Walliman, 2006), as it is completed by respondents themselves without the involvement of a researcher in the process. Walliman (2006) summarised the advantages of the method as quickness, convenience, structured format, private information giving, no researcher influence and large sample coverage, The disadvantages can be a long design and development process, limited answer range, poor response rates and validity of responses.

In this research, the questionnaire method was preferred because it could systematically gather comprehensive information from a large sample with regard to processes, mechanisms and events that took place before and during the trading period. This strengthened the generalizability of the results. However, questionnaire data needed to be structured and systematic to be used in the quantitative analysis. The disadvantage of self-completion questionnaires is the fact that they are based on the subjective judgements of participants which might not always reflect the actual course of events.

Thus, an alternative approach could have been systematic observations, particularly during the trading period, for data to be more objective. However, systematic observation of all the teams would require each team to be observed by at least one researcher for the entire duration. This would have several drawbacks: first, it would have been costly in terms of devoting more man-hours to data collection; second, it might have been distracting for the teams to be observed by a researcher all the time, particularly when they are dealing with challenges; and, third, it would have left no room for teams to manoeuvre in the already crowded and disruptive trading atmosphere. Hence, acknowledging its disadvantages, questionnaires were preferred as the main data collection tool for the quantitative analysis.

Scales and additional items	Sim-1	Sim-2	Sim-3	Sim-4	Sim-5	Sim-6	Sim-7
Pre-Trading Questionnaire							
Scales							
Team Potency	√	√	√	√	√	√	√
Individual Resilience	√	√	√	√	√	√	√
Items							
Any general comments as you approach the trading period of the Game?	√	√	√	√	√	X	X
Post-Trading Questionnaire							
Scales							
Team Resilience	√	√	√	√	√	√	√
Collective Mindfulness	√	√	√	√	√	√	√
Transactive Memory Systems	√	√	√	√	√	√	√
Improvisation	X	X	√	√	√	√	√
Team cohesion	X	X	√	√	√	√	√
Affective Well-being	√	√	√	√	√	√	√
Items							
Did your Company experience any crises during the Game?	√	√	√	√	√	√	√
If so [your company experienced crisis], what was the nature of these?	√	√	√	√	√	X	X
What are the main factors that you feel helped your team's performance in the Game?	√	√	√	√	√	X	X
What are the main factors that you feel hindered your team's performance in the Game?	√	√	√	√	√	X	X

Table 4. Scales and open-ended items

In all seven runs of the simulation, two questionnaires were delivered to the participants: a pre-trading and a post-trading questionnaire (the latest version of both may be found in Appendix - 10.5). The items in the pre-trading questionnaire are intended to capture data with regards to the preparation phase whereas the items in the post-trading questionnaire are intended to capture data with regard to the trading period. Although both questionnaires were largely identical across all seven runs of the simulation, slight changes and improvements were made in their content each year to eliminate problems or questions that yielded little useful data experienced and to probe emerging issues. Table 4 summarizes the scales and additional items used in my study.

Measures

While deciding on which measures to include in the questionnaires as the research team (of the project), we tried to satisfy three crucial criteria. First, we wanted the measures to be able to capture the mechanisms and processes of resilience identified in the literature analysis. We particularly wanted to be able to quantitatively test the relationships proposed in the conceptual model built prior to the data collection. The literature investigation with regards to the antecedents and outcomes of resilience, which I conducted in my first year and is summarized in sections 2.5.1 and 2.5.2, guided the selection of various measures. Moreover, insight gained from my exploratory study was helpful in measure selection. Second, we wanted to use previously tried, robust and valid measures, which were proven to accurately measure what they aimed to measure. Thus, we have used established measures where possible. Third, we wanted as many participants as possible to complete the questionnaires, and to do so in a way that did not feel unduly burdensome. We therefore tried to keep the questionnaires to a reasonable length. Of course, balancing these criteria forced compromises; some scales were included because they were robust although they did not precisely correspond to concepts in the conceptual framework; certain items were developed and included in the questionnaires because the conceptual framework required them, even though they had not been tried before and some scales and items were not included although they might have been useful, in order to keep the questionnaires at a reasonable length. In this section, these measures are described and the reasons behind their selection are explained (the items of measures may be found in Appendix - 10.6).

Team resilience: As illustrated in Figure 5, in this study, resilience is conceptualized as an emergent capacity to effectively respond to challenges. It is extremely difficult to

measure this emergent capacity, as pointed out by several resilience researchers (Carpenter *et al.*, 2001; e.g. Cumming *et al.*, 2005). A thorough analysis of the literature, particularly quantitative empirical studies of team dynamics, revealed that there are only a handful of previously established scales to measure resilience at the collective level. Among these rare studies, Stephens and his colleagues' (2013) have developed a 3-item team resilience scale that aims to measure "a team's capacity to bounce back from a setback" (Stephens *et al.*, 2013, p. 27). They conducted an exploratory factor analysis which yielded a one-factor solution and in their reliability analysis, Cronbach's alpha is measured to be 0.92. Among very limited options, we found this scale to be the most appropriate one to measure team resilience in this research. In the reliability analysis conducted in this study, Cronbach's alpha is revealed to be 0.895.

The scale developed by Stephens *et al.* (2013) was employed in this study, with only minor wording adjustments (we have replaced the phrase "top management team", which was the unit of analysis on their study, with the word "team") and using a 5-point Likert-type scale (ranging from strongly disagree to strongly agree) rather than 7-point version preferred in their study. The reason for the choice of 5-point scale was to standardize the response scales throughout the questionnaires and to keep them compact and easy-to-complete. The scale was included in the post-trading questionnaire to reveal the experienced resilience to the actual challenges and adversities faced, in other words, when a team experiences the "*brutal audit: at a moment's notice, everything that was left unprepared becomes a complex problem, and every weakness comes rushing to the forefront*" (Lagadec, 1993, p. 54).

Collective mindfulness: To measure collective mental models, we used two previously developed scales, one of which is *collective mindfulness*. Previous studies proposed a strong relationship between resilience and collective mindfulness (Sutcliffe, Vogus and Dane, 2016). The concept is introduced by Weick and his colleagues (2008) to define high-reliability organizations' capacity for attention and action and this capacity is found to be effective in responding to challenges and preserving performance levels (Vogus and Welbourne, 2003). I also found this capacity useful while teams were responding to the problems in the exploratory study. Attentiveness, discussion of alternative solutions and having a constantly updated conceptual map of operations, which are three core activities of mindful organizing, were among the sources of success for the first team in the exploratory study. In line with these, this capacity is

included among the proposed precursors of resilience in the quantitatively operationalizable version of my research model.

Weick and Sutcliffe (2007, p. 103) proposed a 9-item scale to measure this capacity. This scale is used in this research to measure collective mindfulness. No adaptation is made to the scale; only a 5-point Likert-type scale (ranging from strongly disagree to strongly agree) is used instead of the 3-point scoring proposed by them (again, with the purpose of standardizing the response scales throughout the questionnaire). This measurement was measured in post-trading questionnaire.

Team transactive memory systems: The second scale used to measure collective mental models was *transactive memory* systems. Several organizational and team resilience researchers have pointed out the importance of shared knowledge of the roles, expertise and current operations to effectively responding to challenges. Weick (1993) conceptualizes this shared knowledge in terms of *virtual role models*; Maynard and Kennedy (2016) adopt *shared mental models* as a concept to refer to it; and Bowers *et al.* (2017) use Austin's (2003) *transactive memory systems* concept. Moreover, in the exploratory study, the first team activated this capacity by an effective background communication system among the individuals and subunits dealing with different aspects of the problem; this enabled them to easily combine the missing pieces of information and solve the problems effectively. Hence, this capacity is included in the conceptual framework as *transactive memory systems*, which Austin (2003) conceptualizes as an effective mechanism of knowledge sharing and processing within teams.

The scale used to measure this capacity is developed by Lewis (2003), who defines it as "the cooperative division of labour for learning, remembering, and communicating relevant team knowledge" based on the earlier work of Wegner (1987) on transactive memory and group mind. The scale consists of three subscales each of which is measured by five items, using 5-point Likert-type response format with points ranging from strongly disagree to strongly agree. Subscales are titled as *specialization*, *credibility* and *cooperation*. Specialization measures the degree to which each team members' knowledge varies from the others in the team; credibility measure the degree to which each member trusts the knowledge level of other members; and lastly, cooperation measures the degree to which the varied knowledge from all team members is combined and used effectively (Lewis, 2003, p. 589). The scale was

developed by Lewis (2003) in three stages: preliminary development, assessment and cross-validity; and carried out over three studies. In all three studies, the Cronbach's alpha values for all the subscales were over 0.75 both at the individual and the team level.

Collective Improvisation: The ability to improvise was first suggested by Weick (1988, 1993) as a source of effective challenge-response. Following his work, Sutcliffe and Vogus (Sutcliffe and Vogus, 2003; Vogus and Sutcliffe, 2012) acknowledged its importance for adapting to unexpected changes; and Kendra and Wachtendorf (2003b) found this ability effective in the demonstration of resilience to 9/11 attacks. Therefore, I included the collective capacity for improvisation in the conceptual framework. In the first two runs of the simulation, it was measured with a single-item developed within the study ("We were able to improvise effectively as the Game progressed"). However, the analyses with single-items were limited in terms of robustness.

Thus, starting with the 3rd simulation, Vera and Crossan's (2005) 7-item scale of "improvisation in teams" was included in the questionnaire. Vera and Crossan's (2005, p. 205) define improvisation as "as the creative and spontaneous process of trying to achieve an objective in a new way". They emphasize that in the previous literature the 'spontaneity' element of improvisation is exaggerated and the concept is mainly associated with positive outcomes, which does not have to be the case (Vera and Crossan, 2005, p. 203). In the development of the scale, they adapted four items from Tierney *et al.*'s (1999) employee-creativity scale and the remaining three items were generated by utilizing Unger and Kernan's (1983) measure of spontaneity and Moorman and Miner's (1998) measure of improvisation. Cronbach's alpha for the 7-item scale is 0.91.

Team cohesion: Particularly in the team resilience literature, several empirical studies found *team cohesion* to be among the enablers of resilience (e.g. Amaral, Fernandes and Varajão, 2015; Morgan, Fletcher and Sarkar, 2015; Vera, Rodríguez-Sánchez and Salanova, 2017). I also observed it to be an important facilitator while overcoming problems in my exploratory study. Hence, I included it in my research model. To measure cohesion within the teams, items from Chang and Bordia's (2001) study were adopted without any adjustments. Chang and Bordia (2001) adopted the items from Widmeyer, Brawley and Carron's (1985) questionnaire, which measured team cohesion in sports teams. Chang and Bordia (2001) adjusted the items to be also used for teams

in different contexts as the items were very specific to the sports teams in their original version. Just as with the collective improvisation scale mentioned above, the team cohesion scale was also used in this study starting from the second year. In the first year, three items constructed specifically for this study were used with the aim of measuring levels of team agreement and team unity. However, later on, the research team decided to use a more robust and comprehensive scale to measure cohesion.

Team potency: Resilience researchers have investigated the effect of *the confidence in an entity's own abilities* on its resilience to the challenges it faced; and proposed that these two concepts have a positive relationship both at the individual (Bowers *et al.*, 2017) and collective (Lengnick-Hall, Beck and Lengnick-Hall, 2011; Vera, Rodríguez-Sánchez and Salanova, 2017) levels. To test this proposition, *team potency* is included in the conceptual framework as defined by Guzzo *et al.* (1993, p. 87) as "the collective belief in a group that it can be effective"; and it is measured using the scale they developed and revised (Guzzo *et al.*, 1993, p. 98). The revised version consists eight items and employs 5-point response scale ranging from 'to no extent' to 'to a great extent', with the internal reliability measured as 0.88. This scale was used without any wording adjustments and also with a 5-point response scale, but with answers ranging from 'strongly disagree' to 'strongly agree' in order to provide consistency throughout the questionnaire.

Team average individual resilience: Resilience scholars have also proposed that there is a relationship between the resilience of a collective entity (a team or an organization) and the resilience of its individual members (Lengnick-Hall, Beck and Lengnick-Hall, 2011; Duchek, 2014). To investigate this, an individual resilience measure was included in the pre-trading questionnaire and I considered it as a control variable in my quantitative analysis. Although a number of scales have been developed by different researchers to measure individual resilience (for e.g. Wagnild and Young, 1993; Block and Kremen, 1996; Connor and Davidson, 2003), the one that best fits with the criteria mentioned above was determined to be the 'Brief Resilience Scale' developed by Smith and his colleagues (2008). They administered the scale to four samples and obtained Cronbach's alpha levels ranging between 0.80-0.91 (2008, p. 97).

Affective well-being: In order to check whether the trading period was sufficiently challenging to the participants, affective well-being was measured in the post-trading questionnaire using Warr's (1990) scale. Warr (1990) suggested several versions of his

scale to measure job-related affective well-being. We preferred the version that has a balance of shortness and comprehensiveness. This version produces a two-factor solution (arousal and pleasure emotions), and includes the emotion items (such as cheerful, depressed, tense, etc.) with the factor loadings higher than 0.40 (Warr, 1990, p. 200). A 5-point Likert-type scale was used as the response format. The main purpose of this measurement within the context of my study was to do a manipulation check to ascertain how challenging the trading period was perceived to be by the participants. If they were feeling positive (such as cheerful, relaxed, enthusiastic) most of the time, then this suggested that the trading period was not creating adequate levels of adversity and hence anxiety for the teams.

Open-ended questions: In addition to the scales, a number of open ended items were used in both the pre- and post-trading questionnaires to collect detailed qualitative information. In the pre-trading questionnaire, a very general item was included, asking respondents about any general comments they would like to add. In the post-trading questionnaire an item asked respondents whether their team had experienced a crisis during the trading period, and, another open-ended question followed for this asking them detail the nature of the crisis. Lastly, two additional open-ended questions asked about any positive and negative factors that had affected their team's performance. These two open-ended items elicited few useful responses and so were excluded for simulations 6 and 7 in order to condense the questionnaire and create space for new items.

Response rate and participant accuracy (whether the participant filled the questionnaire himself/herself) have not been issues for the project. Participants were asked to complete the pre-trading questionnaire in class 1-3 days before the trading period. Post-trading questionnaires were completed immediately after the trading period, before teams received their trading results. Hence, almost all the participants filled them out. This also ensured that the participant himself/herself filled the questionnaire rather than making somebody else fill it for him/her. However, participants were given an option of exclusion from the research and sole inclusion in the educational aspect of the project. This option was represented with a tick/no-tick statement at the end of the questionnaires which was formatted as in Figure 7. The data from the respondents who ticked this item were excluded from the research. Consequently, the response rate has been 99.63% and the percentage of questionnaires used in the analysis was 98.90%.

Opt-Out Clause	
Your responses will be entered into a database containing information from multiple Production Games and used to provide information for you to use in your final report if you wish to do so. Information will be anonymous and presented only as team averages. The database will also be used for UEBS research into team effectiveness and resilience. Please tick here if you do **NOT** want the information you have provided to be used in this way.	

Figure 7. Opt-Out Item

4.4.2 Objective performance data

As pointed out in the introduction chapter, many prior investigations of resilience have been mainly restricted to extreme settings of high-risk industries and one-off disasters. This has led to much resilience research being rather esoteric, limiting its generalizability to wider organizational contexts (Linnenluecke, 2017). In contrast, I wanted to investigate resilience to the more frequent challenges of less extreme operational conditions and be able to advise much wider populations with the results I obtained. An immediate implication of this choice was on my research question. As elaborated in section 2.5.2 of the literature analysis, while the outcome of resilience is *the survival of the organization and its members* in an extreme setting, it is more likely to be *the preservation and improvement of performance* in non-challenging settings. Hence, I identified my second research question as "whether and how resilience is related to performance?"

One of the benefits of the simulation used in this research is that it yields objective measures of performance. As opposed to approaches where performance is measured subjectively, for instance by the subjective judgement of a supervisor, in this research performance was measured by objective indicators of the accuracy and the rapidity of the work done by the teams throughout the trading period. As mentioned above, during the trading period, teams produced greetings cards in accordance with the orders selected from an order board (the marketplace). Outcomes of this production process reflected their performance and were measured by using various indicators. In my analysis, I utilized five performance indicators to represent various dimensions of performance, namely, productivity, quality, efficiency and strategy. Four of these performance indicators corresponded to a different dimension of performance, and the other one measured all dimensions. Below are the details of these indicators:

Profit/Loss: This measure is the ultimate and most fundamental performance indicator in the simulations as well as in my analyses. It takes all the incomings and outgoings of a team into account. It is calculated by adding all the cash and 30% value of all the

assets a team returns to the controllers at the end of the trading period and subtracting all the loans (and their interest) and any fines the team incurred from the value of cash and assets. As it is quite easy to make a loss, this number is negative for the 77.94% of the teams in the research.

This measure is also fundamental to my study as being the ultimate dependent variable in the tests of my research model. My research aims to identify the antecedents of team resilience and to investigate how, in turn, resilience is related to *team performance* in challenging conditions. In this regard, *profit/loss* is used to indicate the team performance in the quantitative investigation of the research model. *profit/loss* is not the only performance variable that is correlated with team resilience, nor has the highest correlation among all the performance indicators. However, I chose it as the ultimate indicator of the performance because it reflects multiple aspects of a team's performance, namely, productivity, quality, efficiency and strategy. In that regard, none of the other performance indicators is as comprehensive as *profit/loss*.

Number of cards delivered: A second essential performance indicator which mainly reflects the productivity dimension of performance is the number of cards produced and delivered by the team to the controllers. This number indicates all the cards that reached the controllers regardless of whether they met the specifications or not. Thus, it essentially measures how fast a team was in producing cards. Since, this is a rather quantity-related performance measure, and hence, number of people allocated to do the production task might affect it in a great deal, a more unbiased measure is '*cards delivered per person',* that is the total number of cards delivered by a team divided by the number of team members.

A similar measure considered as productivity-related was '*number of accepted cards*', or '*accepted cards per head*' that is the number of the cards delivered and accepted by the controllers. I first considered this variable as an indicator of productivity. However, although this variable demonstrates how efficiently a team produces cards, the cards also need to meet the specification. The measure therefore becomes contaminated with the quality aspect of performance and does not effectively reflect productivity aspect of performance. Thus, I decided to use '*cards delivered per person*' in the analyses to determine how productivity-related performance is related to certain variables.

Number of orders rejected: In order to measure quality dimension of performance, which means how accurate the team was in understanding, interpreting and applying

product specifications to their production, we count the number of delivered orders of a team that were rejected by the controllers (as a percentage of total orders taken) because they did not meet the specifications. Teams that are able to address and overcome the challenges of their operational environment (for e.g. lightening and noise problems, inventory problems, problems associated with securing desired orders etc.) may better concentrate their work on producing in line with the strict product specifications. Hence, this measure is expected to be strongly and negatively correlated with resilience. In addition, rejections create frustration and shock within the team, and hence, constitute an additional source of challenges testing their resilience and requiring them to understand and fix the problems with the production process and continue operating. Conclusively, a two-way negative correlation is expected between *team resilience* and *rejection percentage*.

Delivered cards (as a percentage of sheets consumed): Another key performance measure is *'delivery percentage*', which is calculated by dividing the total number of cards delivered (both accepted and rejected cards) by the total number of sheets consumed by the teams. This measure is calculated to understand how efficient the team was in using all the sheets they bought. In particular it measures their internal defect rate, the level of the production errors made prior to bringing the order to its submitted version. Hence, I included this performance indicator to represent the efficiency dimension of performance.

Average value per order: The last essential performance measure is *average value per order*, which is the total cash value of all the orders taken from the order board by a team divided by the number of these orders. This essentially shows the type of orders the team selects in terms of order profitability. Fundamentally, a team with a high average value per order pursued a strategy of taking high value, high profit, but hard-to-complete orders with a high number of cards per order and tight deadlines. In addition, it may also imply how quick a team in identifying the most profitable orders on the order board and in getting them before any other team.

Other measures: In addition to these primary measures, which have been used in the main data analysis, there are also intermediary performance measures that are used in the calculation of the primary measures. They are detailed in Table 30 in Appendix - 10.7.

4.4.3 Other data collection tools

Within the scope of the parent project of my study, a wide variety of quantitative and qualitative data collection methods were utilized. However, within the scope of my study, I only used the part of that data that allowed me to test my research model. As I quantitatively tested several relationships of my research model, I particularly used the quantitative data. Nonetheless, I have also used rich, qualitative data regarding the critical incidents in order to demonstrate the mechanisms behind the relationships I could and could not tested with the quantitative analysis. There are four sources of qualitative data.

Firstly, teams were asked to prepare *strategic plan documents* and to attend *strategic review meetings* with the controllers; both of which were used as qualitative data sources in my study. Both of these sources provide information about the preparation and the strategy formation of the teams prior to the trading period. This information is crucial for differentiating between the teams that prepared and strategized well and those that did not and to link this to team resilience and performance. As pointed out by several resilience scholars (Sutcliffe and Vogus, 2003; for e.g. Weick and Sutcliffe, 2007; Maynard and Kennedy, 2016), *accumulated knowledge* and a *learning culture* is extremely important to formulate effective responses to challenges. The teams in this study were newly formed and they experienced the trading period for the first time, and so, they did not have prior experience or accumulated knowledge. Therefore, the only opportunity for them to accumulate the required knowledge to respond to the challenges of the trading period was to practice and model it in the preparation phase. I therefore used data from strategic plan documents and strategic review meetings in order to examine the relationship between resilience and accumulated knowledge.

I was also involved in several strategic review meetings as a controller. For the meetings I did not attend, I had access to audio recordings to gather the data. From the documents, I gathered information about teams' missions, objectives, strategy and organization. In these documents, teams described what they aimed to accomplish in the trading period, how they hoped to accomplish this mission, what specific approaches they would adopt, and also how they intended to organize themselves (an example template for strategic plan document may be found in Appendix - 10.8). Within this context, teams identified their own strengths and weaknesses; general and specific risks they expected to encounter; and produced a financial plan. Some teams

also indicated the intensity of their preparation for the trading period, in the form of number, duration and attendance level of meetings and practice sessions. Walliman (2006) suggests that, when using documents as a source of data, it is better to support them with other forms of data collection. Thus, through the strategic review meetings I was able to obtain additional information about the preparation and strategies of teams. These meetings lasted about half an hour and had a semi-structured design with standardized guidelines (may be found in Appendix - 0) but some flexibility. Two researchers participated in each meeting, both questioning the team and taking notes throughout the meeting.

Secondly, observational data is gathered during the trading period in the form of *direct observation* and *video-recordings* carried out for all runs of the simulation with different degrees of detail and visual/audio quality (for e.g. for certain runs of the simulation roaming cameras were used in addition to static cameras). The video-recordings may be classified under observational data collection; and, as McKechnie (2008) pointed, observational data may be used both for " the discovery of new information" and for "the validation of existing knowledge". In this regard, I have occasionally used the data gathered from these recordings to understand whether and how the relationships I proposed manifested during the trading period. These recording were particularly important because I acted as a controller for all runs of the simulation and was engaged with administrative tasks for the most of their duration and could not therefore perform systematic direct observations. Therefore, as McKechnie (2008) referred as one of the advantages of observational research, "the rich descriptions" generated as a result of the analysis of these video-recordings facilitated the understanding with regards to the relationship between resilience, its antecedents and its outcomes.

Thirdly, a few days after the trading period, teams were required to *collectively reflect* on their performance in the simulation. Each team had 10-15 minutes to make a presentation followed by 5-10 minutes of Q&A and discussion involving controllers and members from the other teams. Out of 13 presentation sessions, I attended six, and asked questions and took notes during them. The other seven sessions were audio and video recorded; hence, I gathered information from them when needed.

The information gathered from these presentations was extremely valuable. As mentioned previously, it was not feasible to make systematic direct observations during the trading period; first, because all the researchers acted as controllers and

engaged with administrative tasks, and second, observing all the teams all the time would have required a huge research team (considering at least one observer per team, 4-16 observers would be needed for a single run of the simulation). Thus, most of what teams have been through in the simulation is only known to the teams themselves. Team presentations were the main opportunity to hear teams' own accounts of the exercise. Although these accounts are based on self-report, and hence have the potential of not accurately representing the reality, combining these with direct observations and video-recordings helped me to better make sense of their experiences. Thus, I had a much stronger idea of the mechanisms of achieving resilience and satisfactory performance.

Finally, data from the *individual reflective assignments* of participants were also used as a source of qualitative data. Each participant individually completed and submitted a 2000-word report, 2-4 weeks after the trading day and they were graded from them. These assignments were only visible to the faculty members who were teaching the courses in which the simulations were carried out. Therefore, the two faculty members who reviewed the reports extracted the necessary information from these assignments anonymously. I have used this anonymized data to get further information about the challenges teams faced and how they responded to them and to better reveal the mechanisms of resilience and performance.

4.5 Data Analysis

4.5.1 Quantitative data analysis

The quantitative data analysis in this study was carried out using the data gathered from the questionnaires and objective performance indicators. I conducted this analysis using SPSS 24 and AMOS 23. The main purpose of this analysis was to test and validate the various paths of the research model that had been developed as a result of the literature analysis and the exploratory study.

Data entry process:

Data on objective performance were collected during the trading period. For instance, after a team delivered an order and it had been inspected by a controller, the SODN document passed to the data entry team. The SODN shows the details of the order (cash value, number of cards, occasion, colour, size, etc.) as well as the decision of the

controller (accepted, rejected or marked as late delivery). The data entry team, then, recorded the number of cards and the cash value of the order into an Excel database. At the end of the entry process, the total cash value and card amount of accepted, rejected and unfulfilled orders were calculated for each team. To finalize this process and determine the overall performance results, data from the final accounts of the teams (for e.g. value of the loan and the interest incurred, value of the assets left unused at the end) is incorporated into the Excel Workbook.

Data from the questionnaires are processed into a SPSS database after the participants complete and deliver them. Then, to represent the research concepts, scales were calculated by combining data from several items. When the data entry is completed at the individual level, the steps to build the team-level database start. For that, first, the reliability levels were confirmed; second, Inter-rater values are calculated using the methods of Dunlap *et al.* (2003); and third, with the confirmation of inter-rater value levels, variables (including scales) were aggregated to team level. In the final step, the objective performance data is copied into the database from the Excel Workbook.

Variables:

There are four different types of variables in the database. The first type are the demographic variables. These variables provide information about the different characteristics of participating teams and their members. Examples include be gender, nationality, programme of study, team ID, etc. The second type are variables created to quantitatively codify the questionnaire items. Some of these variables directly codified whereas others reverse-coded or the values were grouped. The third type are the construct/scale level variables. These variables are created by using a number of item level variables and by averaging the scores on each item to represent the overall scale score, as instructed in Parke's (2013) work. These variables are crucial for the main analysis as they are reflections of the concepts investigated in this study. The fourth type are performance indicators. The results calculated during the trading period directly processed into the database first (for instance, profits, sales, loans, etc.). Then, based on these primary performance indicators, other more complicated indicators were calculated (e.g. sheet wastage rate, quality rate, etc.).

Analyses:

I utilized various methods in order to test the research model. To begin with, I used descriptive statistics (*mean, range, frequency,* etc.) to provide information about the characteristics of the participants, both at the individual and team level. These statistics give information about the attributes of participating teams and their members. Moreover, I conducted *ANOVA* to determine the significance of the descriptive attributes for the dependent variables (namely, team resilience and team performance). Results of ANOVA helped me decide which demographic measurement variables to include as control variables.

In order to test the one-to-one relationship between resilience and the proposed precursors as well as resilience and performance, I employed **correlation** analysis. Correlation "refers to a group of indices that are employed to describe the magnitude and nature of a relationship between two or more variables" (Sheskin, 2010, p. 265). Such indices do not provide information with regard to a causal inference; hence, one cannot comment on which variable affects the other (Muñoz, 2011, p. 86), without utilising previously established theories or knowledge of the variables' occurrence order. There are several different types of measures (e.g. Pearson's r, Spearman's rho, Kendall's correlation, intra-class correlation, etc.) used to conduct a correlation analysis (Shapiro, 2008, p. 155). Pearson's r, which assumes a linear relationship between two variables and shows the size and the direction of that relationship, is the most commonly used measure among all. The value "r" denotes the correlation coefficient and calculated to reflect the size and the direction of the relationship. Examining the scatter plots between the variables in this study, I decided that the relationships are in linear shape; therefore, I used Pearson's R in the correlation analyses.

Correlation analyses were also conducted to reveal the likelihood of the *multicollinearity* problem in the following regression analyses. Multicollinearity means that one or more independent variables of the regression is strongly correlated and because of that it becomes harder to identify their incremental effects (Vogt, 2011b, p. 198). Correlation analysis is one of the ways to reveal the possibility of multicollinearity: where the correlation between the independent variables of a regression is 0.8 or higher, the researcher should be concerned about such possibility (Kahane, 2014).

Correlation analyses were followed by regression and path analyses for the overall testing of the research model. **Regression** is a statistical analysis technique to demonstrate the relationship between one variable and one or more other variables (Stolzenberg, 2011). Although, generally a causal inference is implied by stating that one variable, called **dependent variable**, is affected by the other variables, which are called **independent variables**, this inference is informal and should be supported by previously established theory. Regression is one of the most commonly preferred analysis techniques to investigate the relationship between variables (Lewis-Beck, 2011), particularly in social sciences, because of the convenience of its implementation and the richness of the information gathered.

When conducting a regression analysis, it is important to demonstrate whether the assumptions of "linear regression analysis" were met in this particular analysis. There are six important assumptions one has to check to see whether the relationship hypothesized may appropriately explained by linear regression analysis (Meuleman, Loosveldt and Emonds, 2013). Firstly, by entering the independent and dependent variables into the linear regression analysis, one assumes that each independent variable's relationship with the dependent variable is linear. To check whether it is true, one should run the **lack-of-fit** test for each independent variable and should get a significance level below 0.05, which means the alternative hypothesis of a non-linear relationship is rejected. Secondly, the regression model should be **homoscedastic**, which means the variation of the model error terms (residuals) should be constant. In order to detect this, scatterplots of predicted values of dependent variable against the standardized residuals should be analysed visually. If the variation of residuals is constant throughout the different predicted values of dependent variable, then the assumption is met. If the reverse is true, then the model is heteroscedastic and the assumption is violated, in which case the inferences made out of the results may be incorrect. Thirdly, there should be no pattern associated with the residuals of the model. In other words, they should be independent. The **Durbin-Watson test** measures whether there is a pattern among the residuals (Boef, 2004). The test statistic takes a value between 0 and 4, where there is perfect negative correlation if it is 0 and perfect positive correlation when it is 4. Thus, a value between 1 and 3 implies that no correlation (i.e. pattern) exists. Fourthly, the distribution of the residuals should be normal (normality assumption). The consequences of a violation of the normality assumption are not as severe as the violation of other assumptions, because regression

parameters are robust against non-normal distributions (Meuleman, Loosveldt and Emonds, 2013). Nonetheless, one can plot a histogram of residuals and visually examine the closeness of distribution to normality. Alternatively, residuals of the regression may be saved and **Shapiro–Wilk** or **Kolmogorov–Smirnov** normality tests may be run on them. Fifthly, there should not be any extreme data points (observations) that affect the results. In other words, the deletion of no single variable should significantly change the results. To detect this, **Cook's distance** values may be calculated for the cases. Any value over 0.5 should be further examined (i.e. the researcher should run the regression without it and check whether there are any significant changes) and any value over 1.0 should be excluded from the analysis (Berk, 2013). Finally, the existence of multicollinearity should be examined. Although an early detection is done by checking the bivariate correlations between independent variables, one should still calculate **VIF values** for the independent variables to make sure this problem does not occur in the analysis. Any VIF value over 10 indicates that multicollinearity is a problem for the analysis (Meuleman, Loosveldt and Emonds, 2013); and hence, the interpretation of the results may be incorrect.

Finally, the overall model was tested by **path analysis**, also referred as *simultaneous equation modelling*, which is a particular form of *Structural Equation Modelling* (Kaplan, 2012). It "is a confirmatory, multivariate technique that looks at causal relationships between variables in a diagrammatic form" (Foster, Barkus and Yavorsky, 2011b, p. 103). In structural equation modelling, the relationship between latent variables are investigated over observed variables. Thus, this technique involves both factor and regression analyses. On the other hand, in Path Analysis, only observed variables are included in the analysis, and hence, no factor analysis is involved. Therefore, Path Analysis may be considered a more advanced form of multiple regression analysis (Foster, Barkus and Yavorsky, 2011a), where categorical variables and more than one dependents can also be included. An additional important difference between Path Analysis and Regression Analysis is the fact that Path Analysis takes the covariances between the independent variables into account, and hence, deals with multicollinearity.

There are four important assumptions of Path Analysis (Foster, Barkus and Yavorsky, 2011a) and they should be considered before interpreting any Path Analysis results. Firstly, the causal relationship(s) proposed should be in a single direction. In other words, the point of all the arrows demonstrating causal relationship in the diagram

should be pointing one way, meaning the model is recursive. Moreover, as in the regression analysis, the residuals should be uncorrelated and the relationships proposed between individual variables should be close to linear form. Lastly, the sample size should be big enough for the results to be interpreted confidently. There are different views in terms of what sample size considered enough. There are some studies that advise a certain absolute number (for e.g. Barrett, 2007) as well as other studies that advise a certain ratio between number of cases and variables or parameters (Jackson, 2003). Foster *et al.* (2011b) suggest a formula between the number of cases and independent variables to decide if the sample size is sufficient. They propose that if there are $[k(k + 1)]/2$ cases (where k is the number of 'predictor' variables) to conduct the analysis, then the sample size is sufficient.

With the results of the path analysis, one may examine the direct and/or indirect effects of the independent variables on the dependent variables. However, in addition to that, path analysis also provides statistics for the overall significance of the model proposed. There are two types of such statistics that may be interpreted to determine whether the model proposed is meaningful in its entirety: **model test statistics** and **approximate fit indexes** (Kline, 2011, pp. 193–5).

Model test statistics are the initial set of statistics considered when a path analysis has been conducted. The model test is similar to the *lack-of-fit* test in a regression analysis, and indicates how far the data is from fitting the model proposed. In that sense, the null hypothesis proposes that the model fits the data, and so, any significant result implies that the level of the fitness between model and the data is low. When one of the most preferred methods of estimation, **Maximum Likelihood,** is used to conduct the path analysis, the model test statistic is called **model chi-square**. As commonly accepted, when the p-value for model chi-square is under 0.05, then the result is accepted as significance and the model fit is low. Nonetheless, many researchers concluded that the model could still be valuable even though the test statistic is significant and measured fit per degree of freedom by dividing model test statistic by degree of freedom (Wheaton *et al.*, 1977, p. 99). As a rule of thumb, if the value is below 5, then the model is accepted to have an adequate fit according to the model test statistic. However, the value of model test statistics is affected by various parameters such as the sample size, the correlation among the observed variables, non-normality, etc. (Kline, 2011, p. 201), hence, researchers proposed other indices that are independent from some of the limitations of the test statistics.

These indices are called approximate fit indexes and generally classified under three categories. Firstly, there are **absolute fit indexes** which measure how successful the model is in replicating the actual covariance matrix (Foster, Barkus and Yavorsky, 2011b). The limitation here, however, as Kline (Kline, 2011, p. 195) stated, "explaining a high proportion of the sample covariances" does not necessarily mean that the model is correct as incorrect models might have the same explanatory power. Secondly, there are **incremental fit indexes**, which measure the appropriateness of the proposed model compared to a baseline model, where zero covariances were assumed. Thus, it is assumed that the higher the covariances between observed variables, the better the model proposed, meaning an absolute model appropriateness is not measured. Lastly, there are **parsimony adjusted fit indexes**, which measures absolute model fit, however, takes the number of parameters into account to eliminate the limitation caused by absolute fit indexes (Marsh, Balla and Mcdonald, 1988, p. 393).

In this study, I reported four model indices to determine the overall fitness of the models proposed. The first statistic is **CMIN/DF**, which is basically model test statistic divided by degree of freedom, and as mentioned above, a maximum value of 5 is desired for better fit. Secondly, **Normed Fit Index (NFI)** and **Comparative Fit Index (CFI)** are reported, both of which are incremental fit indexes developed by Bentler and Bonett (1980) and Bentler (1990) respectively, and they demonstrate the goodness-of-fit compared to "an arbitrary covariance structure model" (1980, p. 599). The values for these statistics range between 0 and 1, and the greater the value is, the better the model fits compared to a zero-covariance model. In addition, CFI has a correction for the small sample problem and this eliminates "the underestimation of fit" (Bentler, 1990, p. 238). Finally, **root mean square error of approximation (RMSEA)** is also reported in this study. This is an absolute fit index developed by Steiger (1990), but additionally has a parsimony adjustment (Kline, 2011, p. 204). The RMSEA has a significance value and if this value is lower than 0.05 (alternative hypothesis), then the model is said to have an adequate fit. Additionally, RMSEA has a distribution with confidence interval and hence a one-sided test could be calculated to determine whether it is significantly above 0.05 (Kline, 2011, p. 206). The p-value that demonstrates whether RMSEA is greater than 0.05 is called **PCLOSE**, and it is also reported in this study to examine the information related to RMSEA (with null hypothesis being RMSEA is between 0 and 0.05, and alternative hypothesis being RMSEA is greater than 0.05).

4.5.2 Utilization of the qualitative data

In addition to the quantitative data, I used qualitative data to reinforce the quantitative findings; to identify the mechanisms behind the relationships revealed by the quantitative findings; and to explore the paths of my research model that I could not test with quantitative analysis. As Gibbs (2012a, p. 7) pointed out, "[i]n qualitative research there is a strong emphasis on exploring the nature of a particular phenomenon", which is why I (selectively) utilized qualitative data to supplement the quantitative data. Although quantitative analysis can test and confirm the research model, it is inadequate in terms of elaborating the processes and the mechanisms behind these relationships. Although quantitative results provide the strength and importance of a relationship, it does not tell how two concepts affect each other. As mentioned before, revealing and understanding the processes and mechanisms of the relationship between resilience and its antecedents is one of the most important gaps in the resilience field. As stated by Kalaian (2008), qualitative data provide "a detailed narrative description and holistic interpretation that captures the richness and complexity of behavio[u]rs, experiences, and events." Thus, by also utilizing qualitative data that provides information from the anecdotes and events occurred during the preparation and trading periods, I aim to reveal the mechanisms behind the relationships tested in the quantitative analysis; and hence, address this important gap.

All the relationships I proposed and tested with my research model come from the literature analysis and the exploratory study I conducted in the first year of my study. Then, within the scope of quantitative analysis, I tested a part of these propositions using quantitative information. Thus, manifestations of these relationships during the trading period or preparation (i.e. how one concept affects the other or how they interact) are not considered in the quantitative analysis process. For example, the results of the quantitative analysis tell if there is a relationship between cohesion and resilience, however, it does not reveal whether and how cohesiveness facilitates resilience, or vice versa. Although this is not a requirement for the quantitative analysis, it is important and very helpful for the accurate interpretation of its findings, particularly to reinforce the propositions of causal relationships. Therefore, to support the quantitative analysis, I utilized the anecdotes extracted from the qualitative data sources.

In addition to this, I could not collect quantitative data for all the relationships proposed in my research model. Thus, some of these relationships could not be tested with quantitative analysis. When this was the case, I utilized qualitative data, extracted information with regards to these relationships and tried to explore them using qualitative data.

I extracted the qualitative data from my own notes of observations of the teams throughout the exercise and from the various information sources available. These sources included strategic review documents, strategic review meetings and their audio recordings, video-recordings of the trading period for each run of the simulation, observations I made during these runs of the simulation, post-game presentations by the teams and their video recordings, and finally, information extracted from the individual reflective reports by one of the other researchers of the project. For each team, I created a separate section in a *Word* document and under these sections, I added all my notes and other written information belonging to the corresponding team.

Then, utilizing a combination of the procedures described by Schreier (2013), Gibbs (2012b), and Lieber and Weisner (2015), I employed simple content analysis and thematic coding on this data to form it into a more structured form. I made particular use of 'concept-driven coding', where categories (or concepts) of the coding scheme are identified before coding the text. These categories "can be taken from the literature and previous research" (Gibbs, 2012b, p. 44). I used my conceptual model and the results of my quantitative analysis to derive my **coding framework**, and collated the information from events and experiences under themes that corresponded to the concepts under investigation. Specifically, after completing the quantitative analysis, I considered the key results of the analysis along with my conceptual framework and identified the important issues to be interrogated in the *Word* document. I prepared a set of keywords and made searches in the document to extract relevant data.

For example, based on the quantitative support for the relationship between *collective mental models* and *team resilience*, I searched the document using the keywords "specialization", "trust", "coordination", "blame", "mistakes", "preparation", "contingency", "plan-B", "flexibility"; and extracted the anecdotes that supported (or questioned) and illustrated the mechanism of this relationship. Similarly, for the parts of the framework that I could not test quantitatively, I searched the *Word* document for pertinent evidence. For instance, to investigate the relationship between *accumulated*

knowledge and *team resilience*, I searched the document using the keywords "knowledge", "knowledge accumulation", "learning", "training", "practicing", "testing", "challenging", "action repertoire", "strategizing", "planning", "specializing"; and tried to understand how different activities of knowledge accumulation helped teams in overcoming challenges. While doing the keyword searches, I paid attention to doing the search for different spellings of the same words (for e.g. specialising vs. specializing) and for the versions with different suffixes (for e.g. specialization and specializing).

I included anecdotes from various teams in this analysis. The most vivid and powerful anecdotes generally came from the best and the worst performing teams. I used these data to further explore the quantitative findings; to demonstrate how the relationships between resilience, performance and proposed collective dynamics formed; and how they interacted with each other. Moreover, I also used it to understand the manifestation of resilience, to explore possible other precursors effecting its manifestation and to elaborate on how resilience contributed to operational performance.

In order to anonymize the teams and the individuals experienced the incidents I analysed in the qualitative analysis, I ordered all 68 participating teams of the study according to their *profit/loss* value; and gave them a corresponding identity number (i.e. the team with the highest *profit/loss* value has been **Team-1** and the team with the lowest *profit/loss* value has been **Team-68**). When I needed to refer a team, I referred using this identity number. Moreover, when I needed to mention an information that might reveal the identity of a team or a person, I anonymized that information as well. For instance, while analysing an incident about cultural problems, instead of revealing the cultures of participants, I used the expressions **Culture-A** and **Culture-B** to refer to the cultures.

4.6 Testable research model and the hypotheses

As illustrated in section 2.6, as a result of the comprehensive literature analysis I conducted in the first year of this study, I developed a tentative research model. Then, I conducted an exploratory study with two teams, where, with the help of the model in Figure 5, I observed and analysed the factors affected the resilience of teams to the challenges they faced. As a result of this analysis, the initial model was improved and

brought into the form in Figure 6. Finally, following the exploratory study, the main study was designed. The design process involved decisions about research methods, data collection tools and implementation. In accordance with this design, I brought the research model to an operationalizable form illustrated in Figure 8, to be investigated in the main study. As mentioned throughout this chapter, data were collected with regard to the concepts operationalized in this model, using various data collection tools that include a combination of objective, observational and self-report measures.

In the model depicted in Figure 8, the concepts I could measure quantitatively were marked in yellow boxes. To guide the quantitative testing process, the hypotheses below were formed in accordance with the research model in Figure 8. For the testing of the relationships in the model which I did not have the quantitative data, I utilized the qualitative data.

Hypothesis 1. Collective mindfulness is positively related to resilience.

Hypothesis 2. Transactive memory systems is positively related to resilience.

Hypothesis 3. Collective improvisation is positively related to resilience.

Hypothesis 4. Team cohesion is positively related to resilience.

Hypothesis 5. Team potency is positively related to resilience.

Hypothesis 6. Resilience is positively related to operational performance.

Hypothesis 7. Resilience mediates the relationship between collective capabilities and operational performance.

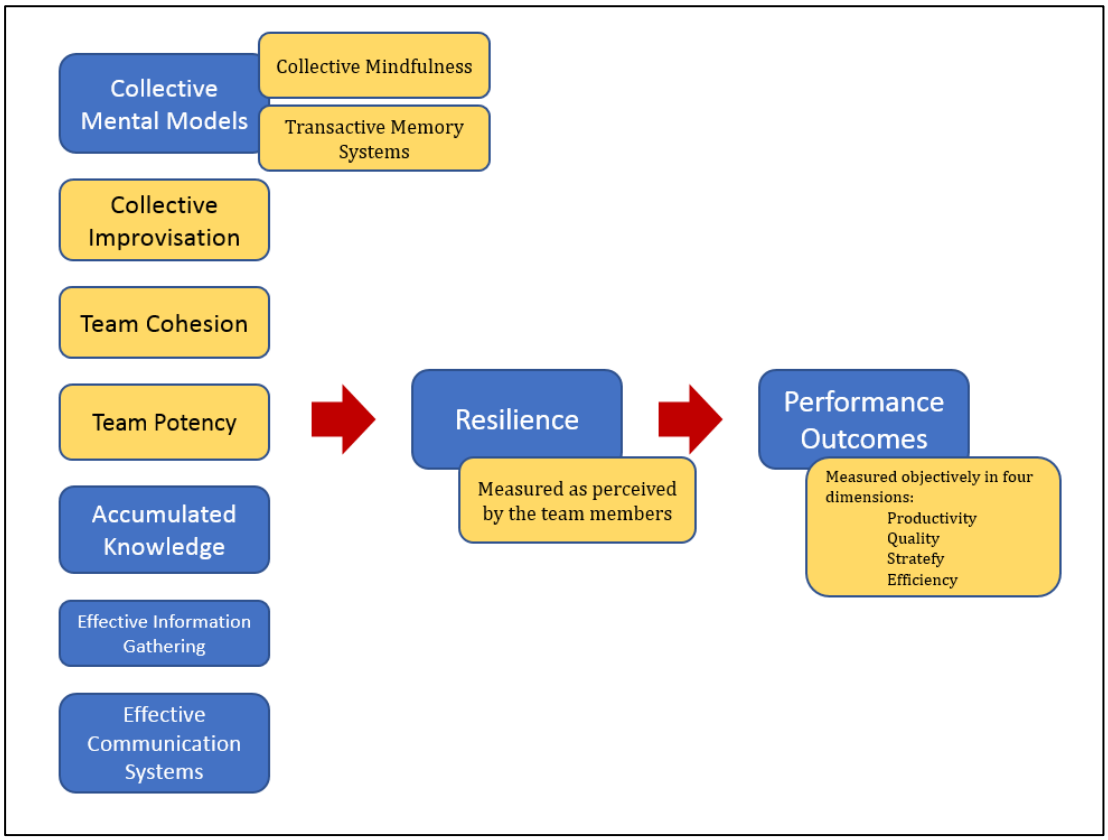

Figure 8. Operationalized research model

4.7 Concluding remarks

In this section, I have described how I conducted the main empirical research in this study. In accordance with the gaps and limitations I identified in the previous studies of resilience and with my initial empirical trial in my exploratory study, I decide to utilize team simulation method for my main empirical investigation. The nature of this simulation is detailed in section 4.3. Following a description of the simulation, I elaborated on the data collection tools utilized to capture data and the analysis methods I employed to obtain the results. Finally, I laid out my operationalized research model and the hypotheses I formulated to guide the analyses. These analyses are reported in the next chapter.

5 Results 1: Quantitative Findings

5.1 Introduction

In this chapter, I present the quantitative findings obtained from my main study. The data I analysed comes from 68 teams and 547 participants, collected over seven runs of the simulation carried out over the course of three years. Quantitative data were collected using questionnaires (see section 4.4.1) and objective performance measures (explained in section 4.4.2). In the first section of the current chapter, I explain the steps of preparing the questionnaire data for the analysis. Firstly, as the analysis is at the team level but the data collected at the individual level, I calculated the interrater agreement rates to make sure there was enough agreement within the teams to aggregate the individual data at the team level. The analysis of this is illustrated in section 5.2.1. Secondly, the concepts investigated in my research are represented by scale variables which are comprised of several items. Thus, to confirm that the validity and reliability levels were adequate, I calculated Cronbach's Alpha values and performed exploratory factor analysis. The results of these analyses are given in subsections 5.2.2 and 5.2.3.

Following these checks, I illustrate the manipulation checks for the simulation in section 5.3. These manipulation checks are presented under two subsections. In the first one, the reactions of participants to the trading conditions are shown. These reactions are important in demonstrating that the conditions of the trading day were perceived as challenging by the participating teams. In the second subsection, the unexpected nature of the simulation is demonstrated. Again, for team resilience to emerge and be manifested, it was necessary for teams to face novel and unexpected conditions and the simulation's adequacy in providing such unexpectedness is evaluated in section 5.3.2.

In section 5.4, I present demographic analysis and descriptive statistics. In the first section, variables associated with resilience, performance and all the other concepts of investigation are introduced, and teams compared with regard to these variables. It is possible to understand the features of the sample in this section. In the second section, the relationships of possible control variables with team resilience as well as with performance examined. Then, according to the significance of these relations, I selected which of these variables of include in the complex analyses.

Finally, the findings from the hypothesis-testing are given in section 5.5 in three subsections: correlations, regressions and path analysis. I formed the subsections according to the nature of the analysis I performed. My logic behind this sectioning is that each analysis type demonstrates different kinds of patterns. Thus, it is more straightforward to present these patterns in separate sections. The hypotheses that guided the main study analyses derived from the operationalized research model presented in Figure 8, section 4.6. I tested these hypotheses tested step by step, following the paths of the research model. At the final step, I tested the validity of the entire model using path analysis in AMOS 23. I provide the results of the hypothesis testing in this chapter. Moreover, the interpretations of the results are also provided in the current chapter; however, implications of these findings are discussed in Chapter 7.

5.2 Data preparation for the analysis

As mentioned above, the pre- and post-trading questionnaires were administered at the individual level by participants before and after the trading period respectively. However, performance required teamwork and, hence, measures were recorded and calculated at the team level. Furthermore, the main unit of analysis was identified as the team and the measures and items of the questionnaire were selected accordingly. Thus, once the questionnaire data were processed into the database at the individual level (for 541 participants), it then had to be aggregated into the team level (for 68 teams) for the planned analyses to be performed. This method of collecting team level data by using individual level questionnaires is a common method in the organizational sciences (van Mierlo, Vermunt and Rutte, 2008, p. 368).

When applying this method, the researcher should adopt a composition model: a form of operationalization at the individual level and a form of aggregation at the team level (van Mierlo, Vermunt and Rutte, 2008, p. 369). Two of the most common methods have been proposed by Chan (1998), both of which are adopted in this research, are *direct-consensus* and *referent-shift consensus* methods. In the direct-consensus method, questionnaire items are worded at the individual level and the construct is operationalized as such, and in aggregating to the team level the construct is adapted to team level (Chan, 1998; van Mierlo, Vermunt and Rutte, 2008). For instance, in this research the construct to measure 'team average individual resilience' is defined at the individual level and the items are worded for individual completion (e.g. "How often

did you feel tense in the game?"). However, the data are aggregated to team level to reflect average member resilience for each team after the trading period. On the other hand, in the reference-shift consensus method, the items are designed or altered to directly make the assessment at the team level (Chan, 1998; van Mierlo, Vermunt and Rutte, 2008). For example, to collect data on collective mindfulness, questionnaire items referred to the team as a whole (e.g. "We discussed our unique skills with each other so that we knew who has relevant specialized skills and knowledge"). All the remaining concepts were measured using this method (team resilience, transactive memory systems, improvisation, cohesion, etc.).

Such aggregation is a straightforward process in SPSS, however, I had to ensure that the data qualified for aggregation. In other words, first, there has to be enough agreement within the teams to confidently conduct analysis on the aggregated data and, second, construct reliability and validity has to be adequate at the team level for each scale that is used in the analyses. In subsection 5.2.1, I illustrate the way I calculated agreement levels within teams and the results I obtained and discuss the results in terms of their adequacy. In subsections 5.2.2 and 5.2.3, I demonstrate the construct reliability and validity at the aggregated level, again, discuss the adequacy of the results.

5.2.1 Interrater agreement (IRA)

5.2.1.1 What is IRA and Interrater reliability (IRR) and why they are used?

As described in LeBreton and Senter's (2007, p. 816) paper, IRA is "the absolute consensus in scores furnished by multiple judges for one or more targets" and IRR is "the relative consistency in ratings provided by multiple judges of multiple targets". In the context of responses to a questionnaire, for team members responding to several questionnaire items, IRA refers to the similarity of the responses themselves among the same team's members and IRR refers to the similarity of the responses given to different items, again, among the same team's members. While aggregating responses from an individual-level questionnaire for the team-level analysis, it is very important to be able to demonstrate that there is enough agreement among the team members to demonstrate the validity of a single response for the whole team. IRA and IRR both indicate the level of the acceptability of the aggregation. If a single item is aggregated, then only IRA can be reported (as there is no relativity between items), however, if a construct formed from several items is aggregated then both IRA and IRR can be reported.

There are several measures of IRA and IRR proposed in different studies. The most popular measure, estimates IRA, is the r_{wg} indices, first proposed by James, Demaree and Wolf (1984). Other commonly used estimates of IRA are standard deviation (proposed by Schmidt and Hunter, 1989), average deviation indices (proposed by Burke, Finkelstein and Dusig, 1999) and a_{wg} indices (proposed by Brown and Hauenstein, 2005). There are also measures that only estimate IRR (for e.g. Pearson product-moment correlation is proposed by Schmidt, Viswesvaran and Ones, 2000) or both IRA and IRR (ICC ratings suggested by Mcgraw and Wong, 1996). In their paper, LeBreton and Senter (2007) detail all the advantages and disadvantages associated with these measures and leave the choice the researcher with the suggestion of justifying the fit of chosen measure with the research.

5.2.1.2 Selection of the measures

In this study, I chose the r_{wg} measure to report the agreement levels among individual responses and justify aggregation to the team level. First of all, it is the most preferred and most cited measure (at the time of writing in April 2018 James and colleagues 1984 work has been cited 4283 times according to Google Scholar Citations). Second, its reporting frame is fairly straightforward ranging from 0.0 to 1.0, 0.0 indicating no agreement and 1.0 indicating perfect agreement. Third, it is not as sensitive to sample size as the standard deviation measure is (LeBreton and Senter, 2007, p. 820), though sample size in the current study is not small. Fourth, it is independent of the effect of IRR as opposed to ICC ratings, in which low values may mean low IRR but high IRA (2007, p. 823). Although IRR is a useful concept, the existence of absolute agreement among the individual responses (which is indicated by IRA) is the main reference point for aggregation. Lastly, I should also note that previous studies concluded that the results obtained with these different measures were similar (Brown and Hauenstein, 2005; Roberson, Sturman and Simons, 2007).

An important issue associated with the r_{wg} measure is the choice of the *null distribution*. While performing the calculation, the researcher has to make an assumption with regard to the distribution of random responding, to compare "the observed variance to the variance expected when judges respond randomly" (LeBreton and Senter, 2007, p. 819). The most straightforward selection is *uniform distribution* where each response point is equally represented (for e.g. for 5-point Likert-type scale each point has 20% chance of being selected). In addition to this, LeBreton and Senter (2007, p. 832)

suggest alternative distributions to assume and use in the calculations (for e.g. skewed, triangular, normal, uniform, etc.).

5.2.1.3 Implementation of the procedures to report r_{wg} values

I adopted the procedures to obtain and report r_{wg} values for the single items and $r_{wg(J)}$ values for the constructs from the appendices of LeBreton and Senter's (2007, pp. 842–849) and implemented these procedures using SPSS 24. The equations I used to calculate r_{wg} and $r_{wg(J)}$ are as follows, where *S* denotes standard deviation and σ denotes the expected variance when there is no agreement, and J denotes the number of items in the construct:

$$r_{WG} = 1 - \frac{S_X^2}{\sigma_E^2} \qquad r_{WG(J)} = \frac{J\left(1 - \frac{\overline{S}_{X_j}^2}{\sigma_E^2}\right)}{J\left(1 - \frac{\overline{S}_{X_j}^2}{\sigma_E^2}\right) + \left(\frac{\overline{S}_{X_j}^2}{\sigma_E^2}\right)}$$

Figure 9. Formulas for r_{wg} and $r_{wg(J)}$

To calculate these equations and in line with the procedures illustrated, first, I sorted the individual data according to *company_ID* (i.e. the identifier of each of the 68 groups). Following the sort, I aggregated all the questionnaire items according to *company_ID* and using *SD function* transferred these to a new database. Then, initially, I calculated r_{wg} value for each item, applying the formula above. As mentioned earlier, for the calculation of the expected variance of random rating (zero agreement), a null distribution has to be assumed. I selected *uniform distribution* as the null distribution, and applied in the calculation of the r_{wg} values. I selected uniform distribution based on the statement made by LeBreton and Senter (2007, p. 827) to give a possible explanation for the r_{wg} values below or above the 0-1 interval. LeBreton and Senter state that one explanation for these *out-of-range values* is inaccurate null distribution selection. With this logic, I calculated r_{wg} values with different null distribution assumptions and I obtained the least number of out-of-range values with uniform distribution. Following the calculation of r_{wg} values for all the items that were intended to be aggregated, I calculated the $r_{wg(J)}$ values for the scales. The final step before reporting these values was to set the remaining out-of-range values (there were only 176 out-of-range values among 8,432 values calculated) to *zero*, as recommended by James *et al.* (1984), assuming that the reason for the occurrence of such values was

attributable to sampling error. The results of the calculations are summarized in the section that follows.

5.2.1.4 r_{wg} and $r_{wg(J)}$ values in this study

Once all the r_{wg} and $r_{wg(J)}$ values were calculated, an important issue was to bring them into a reportable form as there were more than 7,000 r_{wg} values and more than 700 $r_{wg(J)}$ values and it would be very confusing to report all these values. As a solution to this, Cohen *et al.* (2001) recommend reporting mean values. Thus, Table 5 demonstrates mean $r_{wg(J)}$ values for the eight constructs used in this study and the corresponding the acceptance levels advocated by LeBreton and Senter (2007, p. 836). These suggest strong to very strong agreement levels for each of the constructs. Mean $r_{wg(J)}$ values range between 0.87 and 0.97; and for most of the constructs, even minimum values are above the 0.70 cut-off point of strong agreement. As a result of the examination of all the r_{wg} and $r_{wg(J)}$ values, I concluded that IRA levels are high enough to permit aggregation of individual level responses to team scores.

Construct	Number of cases	Mean $r_{wg(J)}$ value	Interpretation	Range
Team Resilience (Post-Trading)	68	0.89	Strong agreement	0.48-1.00
Collective Mindfulness (Post-Trading)	68	0.94	Very strong agreement	0.85-0.99
Transactive Memory Systems (Post-trading)	68	0.97	Very strong agreement	0.89-0.99
Team Cohesion (Post-trading)	47	0.94	Very strong agreement	0.84-0.98
Improvisation (Post-trading)	47	0.91	Very strong agreement	0.64-0.96
Team Potency (Pre-trading)	68	0.95	Very strong agreement	0.88-0.98
Team average individual Resilience (Pre-trading)	68	0.87	Strong agreement	0.63-0.96
Affective Well-being (Post-trading)	68	0.95	Very strong agreement	0.83-0.99

Table 5. Mean $r_{wg(J)}$ values for the constructs

5.2.2 Reliability analysis (Internal consistency)

Reliability refers to "the degree to which measures are free from error and therefore yield consistent results" (Peter, 1979, p. 6). The most common test of the reliability of a construct is Cronbach's Alpha value (Lounsbury, Gibson and Saudargas, 2006). As Cronbach and Shavelson (2004, p. 398) stated in their study, this value can be used to measure "the consistency among items in a test", "agreement among scorers of a

performance test" and "the stability of performance of scores on multiple trials of the same procedure".

In my study, eight constructs were adopted from previous studies (explained in detail in section 4.4.1). Reliability and validity of these constructs were demonstrated in the original studies and in other subsequent studies. The existence of statistics on validity and reliability for these constructs was among the reasons for using these constructs in the current study. However, it is still necessary to demonstrate their adequacy with regard to the concepts within the scope of this study. Therefore, initially, I performed a reliability analysis for all the constructs, conducting two separate analyses for the constructs that were measured both before and after the trading period). The results of this analysis were shown in Table 6.

Construct	No of items	Number of cases	Cronbach's Alpha	Highest Cronbach's Alpha if an item deleted	Average corrected item-total correlation
Team Resilience (Post-Trading)	3	538	0.914	0.888	0.827
Collective Mindfulness (Post-Trading)	9	534	0.856	0.843	0.581
Transactive Memory Systems (Post-trading)	15	524	0.820	0.850	0.468
Team cohesion (Post-trading)	8	375	0.682	0.686	0.396
Collective Improvisation (Post-trading)	7	378	0.763	0.763	0.490
Team Potency (Pre-trading)	8	510	0.859	0.855	0.607
Individual Resilience (Pre-trading)	6	497	0.692	0.706	0.425
Affective Well-being (Post-trading)	12	516	0.849	0.841	0.518

Table 6. Summary of reliability analysis, n=541

There are different views on what constitutes adequate reliability for a construct to be confidently used in further analysis. Peterson (1994) conducted a detailed review of this, examining suggestions from previous studies (1994, p. 382) together with the statistics of reliability levels (of constructs) reported in previous years in several different journals (1994, p. 384). His results demonstrated that average value for

reported Cronbach's Alpha levels is 0.77 and 75% of the reported values were above 0.70 (Peterson, 1994, p. 388). Lounsbury *et al.* (2006) recommended that Cronbach's Alpha for scales should be at least 0.75 or, alternatively, items in the scale should have a corrected item-total correlation of 0.40, which means that the item is adequately correlated with the mean value of all the remaining items. Especially with newly developed scales, a third assessment is the Cronbach's Alpha level if an item is excluded from the scale, although when using a well-established scale, excluding an item in order to achieve a higher reliability level might affect the validity of the scale. As pointed out by Furr (2013) "modified scales might not have the psychometric properties or quality of an original scale".

Considering these insights from previous studies about adequate reliability levels, the scales of *team resilience, collective mindfulness, transactive memory systems, affective well-being* and *team potency* constructs can be read as strongly reliable. They all have sufficiently high Cronbach's alpha levels; and, for each construct, this level either decreases or stays very much the same when any one of the items are excluded. Moreover, corrected item-total correlations are considerably higher than the minimum recommended value.

On the other hand, for the *collective improvisation, team cohesion,* and *team average individual resilience* constructs, the interpretation is more complicated. The Cronbach's alpha for the collective improvisation scale is above the recommended levels, although it is not very high. However, when examining the average value for corrected item-total correlation, it is sufficiently above the level recommended by Lounsbury *et al.* (2006). Thus, the scale is considered adequately reliable. Furthermore, the team cohesion scale is just below the minimum recommended level for Cronbach's Alpha and also just below the recommended level for the corrected item-total correlation. In the light of the fact that this is a previously established and validated scale, it was retained for the analyses. Deleting any item did not improve the reliability of this scale, so all items were utilized. Finally, the Cronbach's alpha for the individual resilience scale is also just below the recommended levels, although the average value for the corrected total-item correlation is at the recommended level. Thus, this scale was retained for the analysis. Removing the item "I usually come through difficult times with little trouble" brought Cronbach's alpha to just above the threshold, however, it was deemed preferable to keep the scale in its original version. So, this item was not removed.

5.2.3 Factor analysis (discriminant validity)

The final step in preparing the data for the analysis was to demonstrate the discriminant validity of the constructs in the questionnaires. This means demonstrating that all the constructs are distinct in terms of what they are measuring; in other words, they are all "nonredundant" (Lounsbury, Gibson and Saudargas, 2006). This is also one of the very limited number of ways to statistically support **construct validity**. Carless (2011) suggests that factor analysis may be used to demonstrate discriminant validity. Although the scales were developed in previous studies, there were no prior models that tested the discriminant validity of these constructs together (Suhr, 2006, p. 5); hence, I decided to measure discriminant validity without specifying a model or the number of factors. In line with this, exploratory factor analysis was conducted (as in Grant (2008) and Golgeci and Ponomarov (2014)), separately for pre-trading items and post-trading items. Table 7 gives the adequacy statistics and Table 8 gives the rotated factor loadings for pre-trading items. Moreover, Table 9 gives the adequacy statistics and Table 10 gives the rotated factor loadings for post-trading items.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.914
Bartlett's Test of Sphericity	Approx. Chi-Square	6886.772
	df	595
	Sig.	<.001

Table 7. Adequacy tests for factor analysis for pre-trading items

Item	1	2
Team Potency		
1	**0.688**	-
2	**0.721**	-
3	**0.778**	-
4	**0.618**	-
5	**0.752**	-
6	**0.536**	-
7	**0.557**	-
8	**0.607**	-
Team average individual resilience		
1	-	**0.519**
2	-	**0.693**
3	-	**0.591**
4	-	**0.729**
5	-	**0.374**
6	-	**0.765**

Table 8. Rotated factor loadings for pre-trading items (factor loading below 0.30 was not included in the table)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.882
Bartlett's Test of Sphericity	Approx. Chi-Square	10252.438
	df	1953
	Sig.	<.001

Table 9. Adequacy tests for factor analysis for post-trading items

Item	Factor Loadings			
Affective well-being				
	4	**7**	**8**	**-**
1	**0.800**	-	-	-
2	**0.655**	0.351	-	-
3	**0.607**	0.367	-	-
4	**0.778**	-	-	-
5	**0.330**	-	0.389	-
6	**0.817**	-	-	-
7	-	**0.754**	-	-
8	-	**0.763**	-	-
9	-	**0.765**	-	-
10	-	**0.273**	-	-
11	-	**0.413**	-	-
12	-	**0.351**	-	-
Team resilience				
	5	**-**	**-**	**-**
1	**0.666**	-	-	-
2	**0.666**	-	-	-
3	**0.622**	-	-	-
Transactive Memory Systems				
	2	**12**	**11**	**5**
1	**0.673**	-	-	-
2	**0.391**	-	-	-
3	**0.653**	-	-	-
4	**0.696**	-	-	-
5	**0.765**	-	-	-
6	**0.425**	-	-	-
7	0.431	**0.376**	-	-
8	0.355	**0.492**	-	-
9	-	**0.727**	-	-
10	-	**0.636**	-	-
11	-	-	**0.306**	-
12	-	-	-	**0.630**
13	-	0.346	**0.512**	-
14	-	-	-	**0.496**
15	-	-	**0.564**	-

Item	Factor Loadings		
Collective Mindfulness			
	6	**9**	**2**
1	**0.332**	-	0.441
2	**0.594**	-	-
3	**0.534**	-	0.310
4	**0.773**	-	-
5	**0.645**	-	0.346
6	**0.475**	-	-
7	-	**0.752**	-
8	0.451	**0.563**	-
9	0.307	**0.634**	-
Team cohesion			
	3	**11**	**14**
1	**0.584**	-	-
2	**0.594**	-	-
3	**0.729**	-	-
4	**0.639**	-	-
5	-	**0.636**	-
6	-	**0.695**	-
7	-	**0.752**	-
8	-	-	**0.833**
Collective Improvisation			
	10	**13**	**1**
1	**0.689**	**-**	**-**
2	**0.677**	-	-
3	**0.632**	-	-
4	-	**0.594**	-
5	-	**0.573**	0.376
6	-	**0.785**	-
7	-	**0.537**	-

Table 10. Rotated factor loadings for post-trading items (factor loading below 0.30 was not included in the table)

To obtain the results given here, I used principal component analysis and I applied an orthogonal rotation (varimax) to determine the factor solution. Along with the principal component method, I also tried the principal axis and the maximum likelihood methods, which are two other dimension-reduction techniques, and I found the factor solutions yielded very similar results. Moreover, for the rotation, I also tried an oblique rotation (direct oblimin) considering the significant correlations between constructs, and, again, obtained similar results. For a more convenient interpretation and to conform to the commonly preferred methods, I used principal component analysis and orthogonal rotation as the final method.

Along with the factor analysis, I implemented Kaiser-Meyer-Olkin (KMO) (Kaiser, 1974) and Bartlett (Bartlett, 1950) tests to confirm that the data were appropriate for the factor analysis. Particularly, there needs to be sufficient correlation among the items that will be entered to the factor analysis (Pett, Lackey and Sullivan, 2011). KMO is a measure of sampling adequacy and, according to Kaiser (1974, p. 35), should be over 0.6 in order for factor analysis to be conducted on the sample. On the other hand, Bartlett's test of sphericity is a hypothesis test where the null hypothesis suggests that there is no relationship among the items. As factor analysis prerequires a certain level of correlation among the items entered into the analysis (Pett, Lackey and Sullivan, 2011), Bartlett's test has to yield a significance level that accepts the alternative hypothesis (i.e. below 0.05). As seen from Table 7 and Table 9 for both pre- and post-trading items KMO and Bartlett tests yielded the desired results, and hence, I was confident that factor analyses were appropriate.

The interpretation of the factor analyses is straightforward for both pre- and the post-trading items. For the pre-trading items, Table 8 demonstrates that all the items from different constructs were loaded under different factors. Moreover, both team potency (*factor 1*) and team average individual resilience (*factor 2*), the items are loaded on a single factor.

For the post-trading items, Table 10 presents slightly more complicated results. In general, factor analysis therefore supported the validity of the main constructs. Items of team resilience (*factor 5*) were loaded on single factors; whereas, affective well-being (*factor 4 and 7*), collective mindfulness (*factors 6 and 9*) and collective improvisation (*factors 10 and 13*) were loaded under two factors; team cohesion (*factors 3, 11 and 14*) loaded under three factors; and transactive memory systems (*factors 2, 12, 11 and 5*)

loaded under four factors. Moreover, almost all the items from different constructs loaded under different factors with two exceptions. First, two items from transactive memory systems loaded onto the same factor as the team resilience items (*factor 5*), and second, three items from transactive memory systems and two items from team cohesion loaded under the same factor (*factor 11*). As these results do not concern the entirety of the scales and apply to a limited number of items, and considering the fact that these three constructs were previously tried and validated in the literature, I decided to use them without any alterations.

5.3 Manipulation Checks

One important question that might be asked about this research is whether the simulation used is capable of generating the conditions for the emergence and the manifestation of resilience on the part of the teams. Although the simulation was designed with the intention of creating challenging conditions and the unexpectedness of a real operational environment, did it achieve this? Did teams have to be resilient in order to perform well? In order to test this, several manipulation checks were included in the research design and the findings from these presented in the next section.

5.3.1 The effects of the challenging conditions

Firstly, it is important to check whether the challenges intended in the design of the simulation were indeed faced by the teams. Regarding this, video-recordings of the trading period are useful in demonstrating the dynamism of the trading period. Participants (and the controllers) rarely have an idle moment throughout the whole trading period. Those selecting orders and procuring materials are constantly 'on the run', shuttling back and forth in between tables and controllers' area. Audio recordings capture non-stop, often disruptive, background noise, proving the ongoing frenzy of audial distraction throughout the trading period.

Furthermore, teams often spontaneously mention the challenges they faced before and on the trading day, during the strategic review meetings and during post-trading team presentations. For instance, regarding the preparation phase, they talk about experiencing adversities ranging from role-related conflicts to the difficult to coming up with realistic production and financial plans that project a profit. In the course of the trading they may experience communication problems which pave the way for crises in

the production process (e.g. inadequate stocks of materials for the order taken or order specifications that are communicated improperly to production workers and are therefore produced incorrectly).

	N	Minimum	Maximum	Sum	Mean
Number of orders rejected	68	0	7	165	2.43
Rejection percentage	68	0.00%	66.70%		20.09%
Number of unfulfilled orders	68	0	7	59	0.87
Unfulfilled orders (as % of orders taken)	68	0.00%	53.85%		6.68%

Table 11. Rejection and non-fulfilment levels

In addition to these, the objective performance data also show the challenges experienced by the team in the form of order rejection and non-fulfilment levels. As seen in Table 11, some teams had as many as 7 rejections and 7 unfulfilled orders, which means their operations faced an unexpected adversity at least 7 times in the trading period. A total of 165 rejections and 59 unfulfillments were experienced over the course of seven runs of the simulation by 68 teams, which means, on average, each team had 2-3 orders rejected and 1 order unfulfilled, i.e. that missed the delivery deadline (see also the **Mean** column in Table 11).

Finally, in the post-trading questionnaire, participants were asked to declare how they felt (in terms of certain emotions) and whether they felt that their team had experienced crisis. More than half of the participants (51.4%) reported that their team experienced a crisis. Answers to the other questions are presented in Table 12 below. As seen from the table, almost all the participants felt **tense** at least once during the trading period. Most of them felt *uneasy* and *worried* at least once; and around a third of them stated feeling even stronger negative emotions such as *depressed* or *miserable*. Moreover, considering less intense negative feelings (tense, uneasy and worried), more than half of the respondents stated that they felt that way at least sometimes during the trading period (these figures include the respondents who stated feeling that particular emotion **always** and the participants who stated feeling that **often** during the trading period). Considering that 82.9% of the respondents *agreed* or *strongly agreed* that they are **individually resilient**, the statements regarding their negative feelings during the

trading period can plausibly be ascribed to the challenging nature of the trading period rather than simply that the sample comprised participants who were naturally inclined towards negative emotions.

Emotion	% stated feeling at least once	% stated feeling at least sometimes	Number of respondents
Tense	94.1%	77.7%	543
Uneasy	80.3%	52.8%	538
Worried	86.0%	54.6%	542
Depressed	38.1%	17.8%	540
Gloomy	37.4%	19.1%	540
Miserable	28.0%	13.7%	542

Table 12. Emotional status of the participants after the trading period, n=541

5.3.2 The unexpectedness of the trading period

The best indicator of the unexpectedness of the trading period is perhaps the difference between what the teams had anticipated they would achieve prior to the trading period (in terms of production and profit) and what they actually achieved. What they actually achieved can be seen from the objective performance data available after the trading period. Their expectations can be seen from their forecasts of production, revenue and profit or loss contained in their pre-trading strategic plans. Table 13 provides descriptive statistics of these forecasts contrasted by the actual results and illustrates the differences strikingly. Except the forecast average for the number of cards produced, overall team forecasts differed significantly from the actual results. When comparing the forecasts with the actual results, it is clear that on average teams performed below their own expectations. Specifically, the performance levels are 20% to 40% lower than forecast for number of order expected to be produced, number of cards produced and value of sales, whereas the actual is **200%** lower than forecasts for profit/loss. Since profit/loss is the product of many factors, it is to be expected that profit was difficult for the teams to forecast. Nonetheless, these differences clearly demonstrate that the trading period conditions were different to what many of the teams had anticipated, including their own ability to produce. Most of the teams generated their forecasts on the basis of their trials conducted before the trading day. Therefore, at least some of the discrepancy between the forecasts and the actual results is likely to have been caused by teams' inability to anticipate the dynamism and the turbulence of the actual trading day atmosphere.

	N	Minimum	Maximum	Mean	Comparison sig.
Profit forecasts (£)	61	-3605.00	7435.00	1102.93	<0.001
Actual Profit/Loss (£)	68	-6879	5478	-1161.79	
Sales forecasts (£)	64	2850.00	19,380.00	6939.13	<0.001
Actual Sales (£)	68	270.00	11950.00	4235.88	
Forecasts for card production (N)	41	48	240	118.12	0.319
Actual number of cards produced (N)	68	32	184	98.94	
Order forecasts (N)	24	5	35	15.42	0.001
Actual number of successful orders (N)	68	2	20	10.35	

Table 13. Forecasts vs. Actual results

5.4 Nature of the data and the identification of control variables

5.4.1 Descriptive statistics

5.4.1.1 Demographic Analysis

In this section, I present the characteristics of the participants of the simulation. These participants, whose data I used to conduct my analyses, have been the students that took a business school course and the simulation has been conducted as a part of that course, as it also facilitates the teaching of the course. As mentioned previously, a total of 547 students participated in the simulation and questionnaire data has been obtained from 541 of them. Table 14 summarizes the demographic data associated with these respondents.

As seen from the table, the sample has fairly equal distributions with regards to gender, nationality and study programme. The participants came from 72 different nationalities, which strengthens the diversity of the sample and allows it to represent cultures and populations from all over the world. Moreover, 64.2% percent of the sample is female and 35.6% is male. This might not be an ideal distribution, however, both genders are still adequately represented. Finally, six different post-graduate level

study programmes are represented by the sample and students enrolled in these programmes come from various educational, occupational and cultural backgrounds.

	Frequency	*Percentage*
Nationality		
China	124	22.9
UK	70	12.9
Germany	48	8.9
USA	38	7.0
India	28	5.2
Thailand	20	3.7
Taiwan	17	3.1
Indonesia	14	2.6
Canada	12	2.2
France	12	2.2
Greece	12	2.2
Mexico	11	2.0
OTHERS	134	25.1
MISSING	1	0.2
TOTAL	541	100

	Frequency	*Percentage*
Gender		
Female	348	64.3
Male	192	35.5
MISSING	1	0.2
TOTAL	541	100
Programme of Study		
MSc_ Management	167	30.9
MBA	134	24.8
MSc-HRM	109	20.1
MSc-IHRM	81	15.0
EMBA	28	5.2
MSc-IBEM	22	4.1
TOTAL	541	100.0

Table 14. Demographic features of the sample

Since data comes from the participants with diverse backgrounds, team performance differences may be related to this diversity. For example, a team might perform better because of having hard-working individuals or individuals that are used to working in teams. So, I also examined the educational, psychological, occupational backgrounds of the participants with the relevant data. Firstly, I analysed the average of the grades they got from the assignments of the course as a proxy for their educational and intelligence related background. Out of 100, the level ranged from 40 to 80 with a mean of 64.09 and a distribution close to normal. Secondly, their self-ratings for the individual resilience construct were analysed as a proxy for psychological background, especially to make sure that teams were not mostly comprised of people with higher-than-normal stress levels. The scores ranged from 1.67 to 5.00 with a mean of 3.66 and a slightly negatively skewed distribution. This slight negative distribution implies that the sample is actually comprised of moderately to highly resilient individuals, hence the main analyses are free from stress-prone participants bias (i.e. the negative feelings

reported by the participants after trading are most likely attributable to the simulation and not to more general negative tendencies). Lastly, in the last two runs of the simulation, participants were also asked to indicate their work experience level as a proxy of accumulated experience. Among the 164 responses, there were participants with no experience as well as participants with up to 34 years of experience. Average work experience was 3.8 years. The distribution for this variable is positively skewed, which means that the sample is mostly comprised of people with low work experience. This is expected as the sample is comprised of post-graduate students.

5.4.1.2 Performance indicators

The trading period generated data from various performance indicators were calculated. Based on these and utilizing the data from procurement forms, within the scope of my study, I have used five of these indicators in the analyses, which the logic of using four of them to represent four dimensions of the operational performance in the simulation and the other one to give a comprehensive performance indication by representing all four dimensions. Table 15 provides the descriptive statistics associated with these variables.

There is a considerable range among the teams in terms of the level of performance. This is particularly observable from the *profit/loss* variable, where the range extended from a loss of –£6,879.00 to a profit of £5,478.00. As mentioned previously, the challenging conditions of the simulation make it difficult for teams to make a profit, and this may be observed from the mean profit/loss of -£1,161.79. In particular, among the 68 teams, only 15 of them broke even. Considering the various aspects of performance, differences among the teams are also visible. Considering the quantity driven performance, there were teams that could only delivered less than 5 cards per person. At the other extreme, almost 20 cards per person were delivered, without any rejections. On average, teams delivered around 12 cards per person, which means, on average, a team produced 1 card every 1.36 minutes. Considering quality, there were teams without any rejections as oppose to teams with 66.7% of their orders rejected by the controllers. Moreover, on average, teams were efficient enough to produce deliverable cards (according to intra-team quality criteria) with more than 80% of the sheets they bought (the maximum value for *delivery percentage* is more than 100% because teams occasionally trade sheets and currently there is not a way to record these trades). Lastly, on average, teams strategized to secure orders with a value around £400.

Variable	Minimum	Maximum	Mean	Std. Dev.	N
Profit/loss (£)	-6,879.00	5,478.00	-1,161.79	1810.37	68
Cards delivered per person	4.57	19.50	12.26	3.64	68
Rejection percentage	0.0%	66.7%	20.09%	15.21%	68
Delivery percentage	31.2%	104.1%	80.57%	14.81%	65
Average value per order	170.0	810.8	403.13	143.62	68

Table 15. Descriptive statistics associated with performance indicators

5.4.1.3 Constructs

With the administration of the pre- and post-trading questionnaires, data were collected for various constructs that represent the different attributes and capabilities associated with resilience. I have used eight of these constructs in the quantitative analysis presented in this chapter. As mentioned before, two of these constructs, namely, *team resilience* and *collective mindfulness* were measured both before and after the trading period. As explained in section 4.4.1, *team cohesion* and *collective improvisation* were measured on in simulations 3-7. All the other constructs were measured for all seven runs of the simulation.

Table 16 summarizes the descriptive statistics associated with these eight constructs. Parametric techniques were used to analyse these Likert scale constructs in line with the 'intervalist position' (Carifio and Perla, 2008, p. 1151), in which researcher assumes the measurement level of the Likert scales to be **interval** rather than ordinal. Although there is an ongoing debate with regards to the measurement level of Likert scales, there are many studies that argue for the appropriateness and acceptability of parametric analysis techniques on Likert scales (Norman, 2010).

In general, descriptive statistics demonstrate that the distributions of the scales are close to normal. Means for the scales range from 3.11 to 4.18 and standard deviations are between 0.19 and 0.55. Only two scales, namely, *team resilience* and *affective well-being*, were found to be significantly, but moderately, positively skewed. Positive skewness might be attributable to response bias, particularly to social desirability, which means respondents' tendency to choose socially desirable responses (Furnham, 1986, p. 385). However, since this is not visible in other scales, one might conclude that it is not the case in this research. Moreover, for the *affective well-being* scale only,

kurtosis is significant. Since no skewness value was outside the ±1 range (Antonius, 2013, p. 106) and no kurtosis value was outside the ±2 range, (Youssef and Luthans, 2007, p. 787), the scale are deemed to have a distribution close to normal. Thus, parametric analysis techniques were used to conduct the further data analysis.

Construct	Min	Max	Mean	Std. Dev.	Skewness	Kurtosis	N
Team resilience	2.67	4.96	4.18	0.55	-0.80	0.10	68
Collective Mindfulness	3.13	4.75	3.98	0.36	-0.05	-0.23	68
Team Transactive Memory Systems	3.30	4.64	4.01	0.33	-0.52	-0.42	68
Collective Improvisation	3.43	4.43	3.90	0.24	0.23	-0.52	47
Team cohesion	3.48	4.56	4.08	0.28	-0.26	-0.80	47
Team potency	3.11	4.58	3.94	0.36	-0.28	-0.28	67
Team average individual resilience	3.04	4.18	3.62	0.24	0.00	-0.16	68
Affective well-being	2.33	4.39	3.66	0.37	-0.92	1.48	68

Table 16. Descriptive statistics associated with the constructs

5.4.2 Selection of control variables

In this section, the control variables and their relationship with team resilience and team performance will be demonstrated. Control variables are the variables that are not the focus of investigation in a research, but which may affect the dependent variable(s) (Taylor, 2012). Thus, in order to be able to see the incremental effects of independent variables on the dependent variables in the presence of the control variables, control variable must be included in the analysis. In other words, if meaningful results are obtained in terms of the relationships between an independent and a dependent variable when control variables are also included, this indicates a direct relationship between dependent and independent variables.

In my study, demographic variables (aggregated to the team level), team size, different runs of the simulation, and *individual resilience* are considered as the candidates for control variables. Demographic variables were introduced in section 5.4.1, however, in order for them to be considered in the analyses they need to be aggregated to the team level. Details of this aggregation are given in the current section. Following this, I

explain which of the candidate variables are considered as control variables along with the reasoning behind the selection.

Any variable that changes from participant to participant and which may affect the dependent variables should be included in the analysis as a control variable. In this study, various items of information were recorded with regard to both individuals and teams; however, not all of this information is the focus of investigation. Some of this information was recorded to control for its possible effects on the dependent variables. The first set of such variables are demographic variables, which are detailed in section 5.4.1. Since the main analysis is at the team level, these variables were aggregated to the team level in order to be included as control variables. Table 17 shows how these variables were aggregated and the associated team level descriptive statistics.

Individual level variable	Team level aggregated version	Mean	Std. Dev	N
Nationality	Number of different nationalities in the team	5.91		68
Gender	Blau Index for gender diversity	0.37	0.15	68
Assignment Grade	Average grade of the team members	64.07		68

Table 17. Aggregation of the demographic variables to the team level

Moreover, there are three more variables that vary from one team to another. First, as mentioned previously, the data were collected over seven runs of the simulation at different times and venues and with different numbers of participants. Thus, the different atmospheres in different settings might have affected team resilience and performance in various ways. Second, sizes of the teams were also varied, between 6 and 10. Teams in greater sizes had more manpower to benefit from, particularly important for production, however, it also meant that more coordination effort is required. Thus, team size might also have affected team resilience and team performance in either direction. Third, I anticipated that the resilience of individual within a team might be effective on the overall resilience of a team as well as on the operational performance, as suggested in the previous literature (Lengnick-Hall, Beck and Lengnick-Hall, 2011, p. 245; Duchek, 2014, p. 863). Hence, I also included team averages for *individual resilience* among the candidates of control variables.

Once I identified the possible candidates for the control variables, I examined their relationships to the dependent variables. Any variable that showed significant relationships with any of the dependent variables was included as that dependent variable's control variable. According to my research model, there are two dependent variables in the main analyses: *team resilience* and *profit/loss (as the team performance indicator)*. Both of these variables are scale level variables, which means all types of statistical analyses can be conducted with them. On the other hand, among the control variable candidates, *number of nationalities, Blau Index for gender diversity, average grade, individual resilience* and *number of team members* are ratio variables whereas the identity of a *simulation* is a nominal variable. Thus, **ANOVA** was conducted to analyse the relationship between *simulation* and dependent variables, whereas **correlation analysis** was conducted for other control variable candidates. Table 18 illustrates the results associated with these analyses. Only average grade and number of team members were significantly correlated with team resilience, so I included only these two variables as control variables in the main analysis. Moreover, the ANOVA analysis for the simulation variable demonstrated that neither team resilience, nor team performance varied significantly for different runs of the simulation. Thus, I did not include it among the control variables.

Candidate	Team Resilience		Control (Y/N)	Profit/Loss		Control (Y/N)
	Co.	**Sig.**		**Co.**	**Sig.**	
Number of nationalities	0.090	0.465	**N**	0.119	0.335	**N**
Blau Index for gender diversity	-0.09	0.465	**N**	-0.021	0.862	**N**
Average grade	0.377**	0.002	**Y**	0.433**	<0.001	**Y**
Number of team members	0.278*	0.022	**Y**	0.271*	0.025	**Y**
Individual Resilience	0.203	0.096	**N**	0.062	0.615	**N**
Simulation	-	0.797	**N**	-	0.337	**N**

Table 18. Analysis results for the relationships between dependent variables and the candidates of demographic control variables

5.5 Steps of the hypothesis testing

Once I processed all the data into the SPSS database and cleaned and prepared the questionnaire data for the analysis, I initiated the hypothesis testing. I laid out the hypotheses I formulated in my study in section 4.6 along with the operationalized version of my research model. I tested these hypotheses using quantitative analysis techniques; and, in the current section, the results of these tests are presented along with their interpretation.

5.5.1 Correlations

In this section, one-to-one relationships between the main constructs of this research are illustrated, using correlation analysis. The section is divided into four parts in which analyses of different kinds of constructs are presented. In the first part, the relationships between various performance measures are shown, in order to elaborate on the various aspects of teams' performance. In the second part, team resilience is also included in the analysis and its relationship with the different measures of performance is demonstrated. In the third part, the relationships between team resilience and the constructs that are proposed as its precursors (see section 4.4.1) are examined. These results played a crucial role in deciding which precursors to include in the overall testing of the research model. Finally, in the fourth part, the correlations between *profit/loss* and the precursor constructs are presented. This is important in order to detect possible direct effects of these constructs on performance.

5.5.1.1 Correlations between various team performance measures

There are various dimensions of a team's overall performance. I identified four such dimensions, namely, quality, productivity, efficiency and strategy. Quality is about the ability to satisfy the product specifications; productivity is about the pace of completing the orders taken, efficiency is about the cost of production both in terms of use of materials and labour hours; lastly, strategy is about identifying the most suitable orders (in terms of profitability and compatibility to particular team dynamics) and the ways to secure these orders. These dimensions are most comprehensively integrated and reflected in *profit/loss* variable. Hence, I used *profit/loss* as the indicator of operational team performance in the complex analyses, namely regression and path analysis. In addition, in less complex analyses, namely correlations, I also used other four performance indicators to understand the relationship of resilience with various performance dimensions.

In Table 19, the performance indicators and corresponding performance dimension(s) are given. As seen, *profit/loss* gives indication of all four performance dimensions because; (1) teams need to be fast to deliver as much orders as possible to get paid more, (2) all the cards of a delivered order have to satisfy strict product specifications, (3) teams need to spend and waste as low as possible not to decrease their overall profit, and (4) they need to strategize for and secure high-value orders to increase profits. On the other hand, other performance indicators, namely, *cards delivered per person* (productivity), *rejection percentage* (quality), *delivery percentage* (efficiency) and *average value per order* (strategy) corresponds to specific dimensions.

	Productivity	**Quality**	**Efficiency**	**Strategy**
Profit/loss	X	X	X	X
Cards delivered per person	X			
Rejection percentage		X		
Delivery percentage			X	
Average value per order				X

Table 19. Performance dimensions and corresponding variables

As a result of covering different performance dimensions in different ways and at different levels, not all performance indicators are expected to correlate strongly. In fact, I anticipated that some of them might not correlate at all. This may also imply different dimensions of performance has different relationships with resilience. Table 20 illustrates the results of the correlation analysis between these variables. As expected, *profit/loss* has meaningful correlations with all the other performance indicators, significant at least at the 0.01 level.

	Variable	1	2	3	4	5
1	Profit/Loss	-				
2	Cards delivered per person	0.42**	-			
3	Rejection percentage	-0.62**	-0.19	-		
4	Average value per order	0.49**	0.29*	-0.13	-	
5	Delivery percentage	0.57**	0.31*	-0.30*	0.21	-

Table 20. Correlations between various performance measures
**significant at 0.05 level, **significant at 0.01 level*

As expected, there are mostly weak and non-significant relationships between the different performance dimensions. For instance, for the relationship between *cards delivered per person* and *rejection percentage*, the value of r is -0.19 with no significance even at the 0.05 level, as the former is about productivity and the latter is about quality. With the similar logic, *rejection percentage* is also not significantly correlated with *average value per order*; *average value per order* is not significantly correlated with *delivery percentage*; and, *cards delivered per person* is only weak to moderately correlated with *average value per order*, only at the 0.05 level.

This analysis demonstrates that in this research, as possibly is the case for other performance related settings, performance has different aspects and associated with various different decisions and actions. Therefore, various constructs investigated in this research, particularly team resilience, might be related to these different aspects of performance differently; or might be related to some aspects and not the others. The following parts of this section provide insights regarding these propositions.

5.5.1.2 Correlations between team resilience and various team performance measures

Using the *team resilience* construct from the post-trading questionnaire, I conducted a second set of correlation analyses in order to examine the one-to-one relationships between team resilience and various indicators of team performance. As mentioned above, these indicators correspond to one or more dimensions of performance. Therefore, different strength and significance levels of correlations demonstrate how resilience is related with each of these dimensions, which explained and illustrated in the previous section. Table 21 summarizes the statistics associated with the correlations between team resilience and various performance measures.

Performance measure	Corresponding dimension(s)	Correlation coefficient	Significance level (α)	N
Cards delivered per person	Productivity	0.251	0.039	68
Rejection percentage	Quality	-0.764	<0.001	68
Delivery percentage	Efficiency	0.399	0.001	65
Average value per order	Strategy	0.198	0.106	68
Profit/loss	Quality, Productivity, Efficiency, Strategy	0.625	<0.001	68

Table 21. Correlations between team resilience and various performance measures

According to the results of the analyses, *team resilience* has the most strong and meaningful correlation with *rejection percentage*; hence with the quality dimension of performance. This relationship is negative; and this was expected as (1) the teams that cannot address and overcome the challenges of the operational environment are expected to experience detriments in operational performance and (2) the experience of rejections may increase the stress levels within the team and hence decrease the efficiency of challenge-response processes. During the trading period, when teams experienced challenges and these challenges interfere with the operations, it is mostly reflected on the quality decreases in the products. While trying to meet the deadline of an order and simultaneously responding to challenges, the concentration on satisfying quality criteria deteriorates and hence rejections increase.

Results demonstrate that quality decreases are followed by the decreases in efficiency and productivity. When teams start to make more mistakes because of the challenges, their wastage rate increases, which lowers efficiency, and they also slow down to avoid mistakes, which decreases productivity levels. Strategy might also be slightly affected, as increased rejections and decreased productivity may turn teams towards easier and low profit orders (i.e. open orders or orders with fewer cards and/or longer lead times), at least in the short-run. However, this is not supported by the evidence: *Team resilience* has a weak and non-significant correlation with *average value per order*, the variable that reflects the strategy dimension of performance.

5.5.1.3 Correlations between team resilience and the precursor constructs

Following an initial analysis of the relationship between resilience and performance, I conducted an initial analysis of the relationship between resilience and it proposed antecedents. My main purpose in conducting this analysis was to identify the precursor variables to be used in the regression analysis, in order to reveal any incremental effects of these constructs on resilience. The precursors which have meaningful relationships with resilience were considered in the next stages of hypothesis testing and entered into the regression models. In the current section, I also examine the correlations between the precursors in order to check for *multicollinearity*. Table 22 demonstrates the correlations between *team resilience* and precursor constructs. All the correlations were run for 68 teams except those of *team cohesion* and *collective*

improvisation as the data for these two variables were collected only in simulations 3-7. Hence, data only exist for 47 teams.

		1	2	3	4	5	6
1	Team resilience	-					
2	Collective mindfulness	0.79**	-				
3	Team transactive memory systems	0.86**	0.80**	-			
4	Team cohesion	0.73**	0.67**	0.70**	-		
5	Collective improvisation	0.64**	0.50**	0.61**	0.53**	-	
6	Team Potency	0.13	0.25*	0.11	0.34*	0.12	-

Table 22. Correlations between team resilience and the precursor constructs
**significant at 0.05 level, **significant at 0.01 level*

According to the results, *team resilience* is very strongly correlated with *team transactive memory systems*; and strongly correlated with *collective mindfulness*, *team cohesion* and *collective improvisation*. All these correlations are significant at the 0.01 level. On the other hand, *team resilience* is not found to be significantly correlated with *team potency*. In accordance with this, I included *transactive memory systems*, *collective mindfulness*, *team cohesion* and *collective improvisation* in the regression analysis and excluded *team potency* in the following steps. Among the precursors, the ones showing a strong association with resilience, namely, *transactive memory systems*, *collective mindfulness*, *team cohesion* and *collective improvisation*, are also strongly and significantly correlated with each other. Since these are the variables considered for the regression analysis, it is necessary to check the possibility of multicollinearity. In accordance with the rule of thumb (Kahane, 2014), between *transactive memory systems* and *collective mindfulness,* there is a possibility of 'close to perfect' linear relationship. Thus, in the regression analysis, multicollinearity statistics must be calculated and treatments applied if needed.

5.5.1.4 Correlations between team performance and the precursor constructs

I ran a final set of correlation analyses in order to investigate the relationships between performance and various precursor constructs. As in the previous analysis including performance, all five performance variables were included to reflect different performance dimensions: *profit/loss,* as the overall indicator of team performance; and

four other variables, each reflecting the different dimensions of performance. All precursor constructs were included in the analyses. Table 23 summarizes the results.

These tests yielded parallel results to those in the previous section which is to be expected as we have already seen that team performance is related to team resilience. Four precursors strongly associated with resilience, namely *collective mindfulness*, *team transactive memory systems*, *team cohesion* and *collective improvisation*, were also found to be positively associated with *profit/loss*. The strength of the relationships is strong for the former two, and moderate for the latter two. Performance is not significantly correlated with *team potency*. Furthermore, precursors showed various levels of relationships with the dimensions of performance. Quality (represented by *rejection percentage*) is strongly and meaningfully correlated with *collective mindfulness, transactive memory systems*, *team cohesion* and *collective improvisation*. Quality (represented by *rejection percentage*) requires common group understanding with regards to the product specifications; and the application of this understanding requires proper coordination along with novel adaptations when existing action repertoire is ineffective. Hence, these results are expected.

	Profit/Loss		**Rejection percentage**		**Cards delivered per person**		**Delivery percentage**		**Average value per order**	
			Quality		Productivity		Efficiency		Strategy	
	r	N	r	N	r	N	r	N	r	N
Collective mindfulness	0.51**	68	-0.63**	68	0.22	68	0.25*	65	0.27*	68
Team transactive memory systems	0.63**	68	-0.75**	68	0.18	68	0.29*	65	0.27*	68
Team cohesion	0.33*	47	-0.53**	47	0.32*	47	0.11	44	0.09	47
Collective improvisation	0.37**	47	-0.49**	47	0.15	47	0.10	44	0.08	47
Team Potency	0.10	67	0.05	67	0.33**	67	0.11	64	0.20	67

Table 23. Correlations between performance and precursor variables
**significant at 0.05 level, **significant at 0.01 level*

Moreover, *collective mindfulness* and *team transactive memory systems* were also found to be associated with *average value per order*, which represents strategy and *delivery*

percentage, which represents efficiency. This was also expected as these aspects of the performance require effective application of collective cognitive capacities. Collective evaluation of alternative models, for instance, may facilitate the formation of effective strategies. Moreover, effective specialization of individuals on various required tasks of the operations; and accomplishment of these tasks in a coordinated manner may provide for efficiency. Furthermore, *team cohesion* was found to be moderately correlated with *cards delivered per person*, which represents productivity dimension of performance. Productivity is more about maintaining production rather than applying collective cognitive skills and maintaining production might require providing for harmony in action. Thus, the interpretation of this result might be that well "aligned thoughts and behaviours" (Morgan, Fletcher and Sarkar, 2015, p. 98) of the team members speed up the production process.

5.5.2 Regressions

I used the regression technique to analyse the individual paths of my operationalized research model, as an intermediary step before testing the overall model. The analyses were conducted to investigate the effects of various independent variables on *team resilience* and *team performance*. Hence, in the first part of this section, I conducted two regression analyses, where *team resilience* was the dependent variable which was entered into the analysis along with the previously identified control variables and precursor constructs as independent variables. Following that, in the next phase, I conducted another regression analysis with *team performance* being the dependent variable and *team resilience* being the independent variable along with control variables identified in section 5.4.2. All regression analyses were conducted using the hierarchical analysis method in which independent variables are entered according to an order decided by the researcher (Vogt, 2011a, p. 143). In all analyses, control variables are first introduced and then, independent variables added.

5.5.2.1 Precursors of team resilience

In order to test the hypotheses with regards to the relationship between quantitatively operationalized precursors and team resilience (namely the hypotheses 1-4), I ran two regression analyses, treating *team resilience* as the dependent variable and the proposed precursors as the independent variables. In the first analysis, I used a hierarchical analysis method to determine the effects of *collective mindfulness,*

transactive memory systems, team cohesion and *collective improvisation* along with the control variables proposed, namely, *average grade* and *number of team members.* In the first order, only control variables were entered into the analysis, and then, in the second order, all precursor variables were included in the model. Table 24 summarizes the results of this analysis.

	Model 1	Model 2
	Standardized coefficient (significance level)	
Intercept	- (0.28)	-(0.00)
Independent variables		
Collective Mindfulness	-	0.23(0.05)
Transactive memory systems	-	0.47(0.00)
Collective improvisation	-	0.13(0.14)
Team cohesion	-	0.15(0.16)
Control variables		
Average grade	0.46(0.00)	0.05(0.54)
Number of team members	0.28(0.04)	0.05(0.48)
R^2	0.27	0.81
Adjusted R^2	0.24	0.79
F	8.290	29.020
Sig.	0.001	<0.001

Table 24. Regression analysis: Team resilience as the dependent variable, n=47

For the regression analysis summarized in Table 24, I conducted all the tests to check for any violation of the regression assumptions. Firstly, for all the independent and control variables, I ran simple regressions where *team resilience* was treated as the dependent variable. For all these simple regressions, I conducted lack-of-fit tests and none were significant, indicating that the proposed relationships are not significantly non-linear. Then, I ran tests and graphs for the residuals. The scatterplot of predicted values of dependent variable against the standardized residuals shows that the variation of residuals is close to constant and without any clear pattern (Figure 10). Thus, the model is homoscedastic. Moreover, I calculated statistics for Shapiro–Wilk (α=0.79), Kolmogorov–Smirnov (α=0.20) and Durbin-Watson (test stat = 2.49) tests and the statistics suggest that the residuals are independent and normally distributed. Following this, I calculated Cook's distance values and observed that none of them are

big enough to be considered as extreme cases (max = 0.18). Lastly, I also calculated VIF values and observed that none of them were above 10 (max = 3.55), which demonstrates that multicollinearity is not an issue for the analysis.

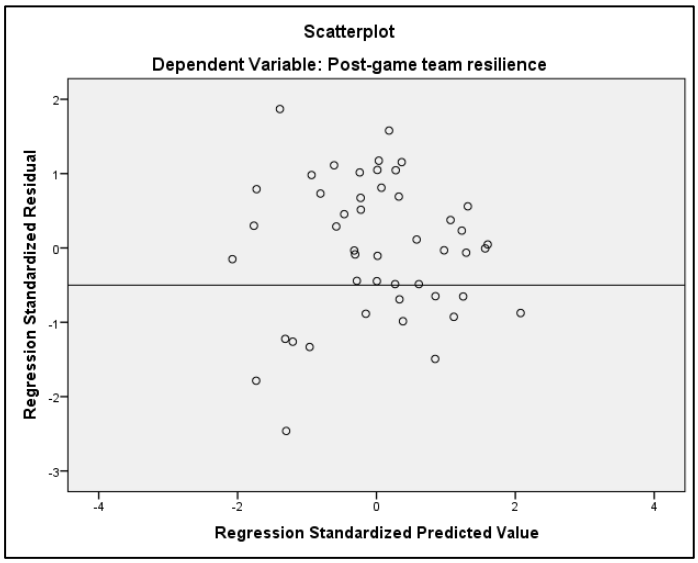

Figure 10. Scatterplot of predicted values of dependent variable against the standardized residuals

Since all the regression assumptions are met with this analysis, I decided that I could confidently make inferences from the regression statistics. Firstly, with only control variables in the analysis (Model 1), the base adjusted R^2 is 0.24 and base F is 8.290. In this model, the coefficients for both control variables, namely *average grade* and *number of team members* are significant with standardized *Beta*s of 0.46 and 0.28 respectively. Following Model 1, in Model 2 all the proposed independent variables (team capabilities and characteristics) were included in the analysis. This yielded a higher adjusted R^2 (0.79) and an F-value of 29.020. In this model, the effects of all the control variables were non-significant. Among the independent variables, *collective improvisation* and *team cohesion* was non-significant. The other precursor variables, namely *collective mindfulness* and *transactive memory systems* were significant at the 0.05 level. In general, both models were significant, and Model 2 had a significant intercept. Only 47 teams were included in the analysis, since the data for *team cohesion* and *collective mindfulness* were only collected in simulations 3-7.

In the first regression analysis, *collective mindfulness* and *transactive memory systems* appeared to be the most effective precursors of *team resilience*. Since this analysis was

based on only 47 teams, I decided to run a second regression analysis using all 68 teams, since data for these two precursors were collected for all teams. In this second analysis, all the control variables suggested beforehand were used. Two models were analysed using hierarchical regression analysis. Like the previous regression analysis, in the first model, only control variables were included in the analysis. In the second model, both precursor variables were introduced along with the controls. This analysis is summarised in Table 25.

	Model 1	Model 2
	Standardized coefficient (significance level)	
Intercept	- (0.42)	- (0.00)
Independent variables		
Collective Mindfulness	-	0.24 (0.02)
Transactive memory systems	-	0.62 (0.00)
Control variables		
Average grade	0.36 (0.00)	0.08 (0.20)
Number of team members	0.26 (0.02)	0.10 (0.10)
R^2	0.21	0.78
Adjusted R^2	0.18	0.77
F	8.486	57.177
Sig.	0.001	<0.001

Table 25. Regression analysis: Team resilience as the dependent variable, n=68

For this second analysis, too, all the assumptions of linear regression analysis were met. First of all, as mentioned above, for all the independent and control variables, lack-of-fit tests were non-significant, which means that the relationship of all these variables with *team resilience* may be accepted as linear. Secondly, I conducted analyses to confirm that the regression residuals were homoscedastic, independent and normally distributed. Standardized residuals were plotted against *team resilience* (Figure 11), and I observed no obvious pattern and only one data point outside the ±2 range, hence I concluded that the data were homoscedastic. Moreover, I calculated Durbin-Watson (test stat = 2.63) test for the regression analysis and Shapiro–Wilk (α=0.93) and Kolmogorov–Smirnov (α=0.20) tests for the saved residuals; and the results demonstrated that the residuals are independent (no autocorrelation was observed among them) and normally distributed. Thirdly, there were no Cook's distance value

over 0.5 (max=0.12), hence, no case was considered as extreme. Finally, no VIF value was over 10 (max=2.90), meaning that multicollinearity is not a problem for the analysis.

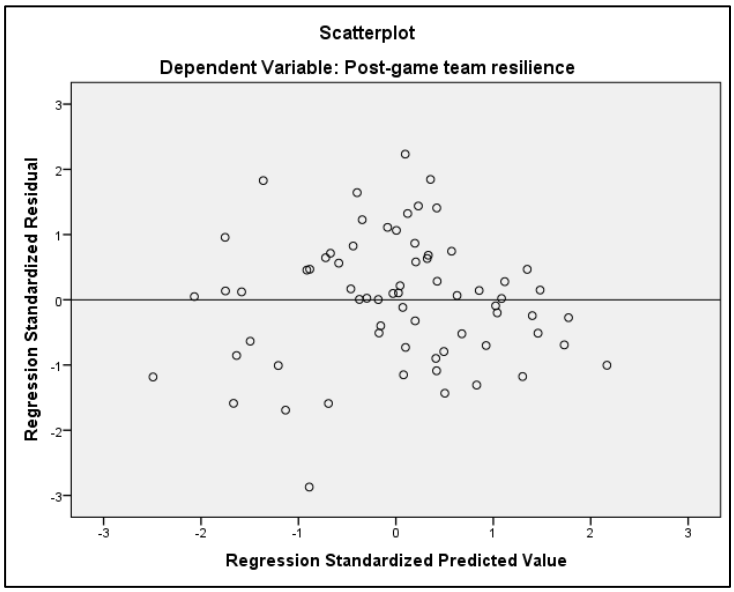

Figure 11. Scatterplot of predicted values of dependent variable against the standardized residuals

Considering the analysis results, overall, both models were significant and had significant intercepts. In Model 1, where only control variables were included, the adjusted R^2 was 0.18 and the base F was 8.486. Similar to the results with n=47, the effects of both variables were significant, though the significance levels were higher. However, again similar to the results with n=47, these significant relationships were found to be spurious and disappeared when *transactive memory systems* and *collective mindfulness* were introduced in Model 2. In Model 2, adjusted R^2 increased to 0.77 and F increased to 57.177. The effects of all the control variables became non-significant. When n=68, the standardized beta (0.24) of *collective mindfulness* decreased slightly although its significance level (0.02) improved; and conversely, the standardized beta (0.62) of *transactive memory systems* increased and its significance level (0.00) remained the same. This analysis confirmed that the results when n=47 were robust and did not change majorly when the number of cases were increased to 68.

After confirming hypotheses with the correlation analyses, with the regression analysis, I wanted to achieve two goals: first to understand the cumulative explanatory power of

all the proposed precursors for team resilience; and second, to validate that the relationships confirmed by the correlational analyses were not spurious and did not disappear when tested along with the other relationships. Regarding the first goal, all models are significant at the 0.01 level (and even at the 0.001 level) and when proposed precursors are included in the Model, the adjusted R^2 is adequately high (>0.75). In terms of the incremental effects, each independent variable shows different significance and different standardized power in relation to *team resilience*. To begin with, when the proposed precursors are included in the models, the standardized effects of control variables decrease. This powerfully signals the superficiality of the effects of the control variables. Moreover, among the four proposed precursors, c*ollective mindfulness* and *transactive memory systems* are found to be significantly related to *team resilience* at the 0.05 level. On the other hand, the incremental effects of c*ollective improvisation* and *team cohesion* were not significant. Hence, these analyses served as further validation of the hypotheses 1 and 2; whereas there was not enough evidence to support hypothesis 3 and 4.

5.5.2.2 Team resilience and team performance

Following the analyses to identify the precursors of team resilience, I tested hypothesis 6, which proposes that 'resilience is positively related to operational performance'. Although this hypothesis has initially been confirmed in section 5.5.1.2, and at an initial glance it may appear that a simple regression analysis is sufficient to test it, the analysis in section 5.4.2 demonstrated that there are other variables (control variables) that are associated with team performance, and hence, they should also be included in the analysis. As a result of the previous analyses, I identified these control variables as *average grade* and *number of team members*. Moreover, I included the *team resilience* construct, data for which were collected via post-trading questionnaire, as the independent variable. Finally, as explained in section 5.5.1.1, I identified *profit/loss* as the ultimate indicator of team performance because it reflects multiple performance dimensions, and hence, I selected it as the primary dependent variable in this regression analysis. The results of the analysis were presented in Table 26.

As in the previous section, I conducted a prior step of interpreting the regression analysis to confirm that all the assumptions were met. Thus, initially, I put each independent variable individually into the regression analysis with using *profit/loss* as the dependent variable and ran lack-of-fit tests to see whether the relationships were linear. Except for *number of team members* variable, all the tests results were non-

significant, suggesting that the relationships are close to a linear format. As *number of team members* has limited different values (6, 7, 8, 9 or 10), this result was partially expected. This variable was subsequently omitted as regression analysis results demonstrated that its effect was relatively low and non-significant. Following this, I conducted analyses to test the homoscedasticity, independence and normality of regression residuals. Figure 12 demonstrates that there is no obvious pattern among standardized residual data points along the different values of *profit/loss* variable, and only a few data points are outside the ±2 range, hence, the data are accepted as homoscedastic. The statistic for the Durbin-Watson test was 2.24 which means that the residuals are independent and both Shapiro–Wilk (α=0.25) and Kolmogorov–Smirnov (α=0.20) tests results were non-significant which means that the residuals are distributed normally. Following this, the largest Cook's distance value was 0.42, which means that there were no extreme values that individually affected the results of the regression analysis. Finally, the biggest VIF value was 1.168, meaning that multicollinearity does not exist in the analysis.

	Model 1	Model 2
	Standardized coefficient (significance level)	
Intercept	- (0.00)	- (0.00)
Independent variables		
Team resilience	-	0.50 (0.00)
Control variables		
Average grade	0.42 (0.00)	0.24 (0.02)
Number of team members	0.24 (0.03)	0.12 (0.24)
R^2	0.25	0.45
Adjusted R^2	0.22	0.42
F	10.642	17.301
Sig.	<0.001	<0.001

Table 26. Regression analysis: Profit/Loss as the dependent variable, n=68

Examining the regression results, one may conclude that the overall model is meaningful with a significance level lower than 0.001. The base adjusted R^2 level is 0.22 and the base F level is 10.642, where only control variables are included in the model. When *team resilience* is introduced to the model, the adjusted R^2 level increases to 0.42 and the F-value increases to 17.301. In addition, all the standardized betas and

significance levels for the control variables decreases, which suggest that inclusion of *team resilience* removes the spurious effects. However, *average grade* is still influential even after the inclusion of *team resilience.* The standardized beta for *team resilience* is 0.50 and the significance level is lower than 0.001. When *team resilience* is included in the model, the explanatory power of the model increases significantly, marked by a 0.20 increase in adjusted R^2. It may be argued that an R^2 level of 0.42 is rather low, however, this study does not try to reveal all the precursors of team performance, but rather tries to understand the relationship between team resilience and team performance.

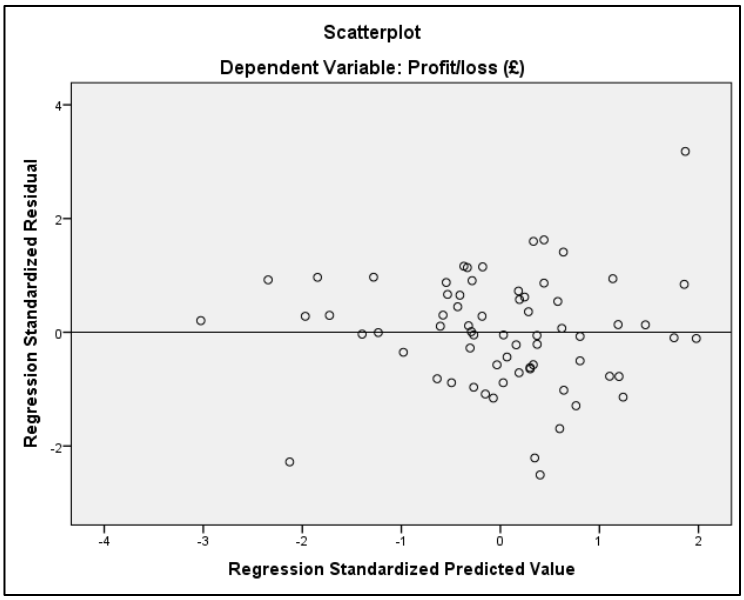

Figure 12. Scatterplot of predicted values of dependent variable against the standardized residuals

This result was expected as explained in detail in section 2.5.2 of the literature review and in section 3.5.4 of the exploratory study. Various scholars have conceptualized performance as a natural outcome of resilience when faced with challenges (Pulley, 1997; e.g. Reason, 2000; Sheffi, 2005). Moreover, several other researchers have explicitly stated that resilience leads to better performances (Weick and Sutcliffe, 2007; e.g. Lengnick-Hall, Beck and Lengnick-Hall, 2011; Maynard and Kennedy, 2016). Lastly, quite a few empirical studies of resilience investigated the effects of demonstrating a resilience capacity in the form of maintained and/or increased performance levels (e.g. Gittell *et al.*, 2006; Furniss *et al.*, 2011; Gomes *et al.*, 2014; Meneghel, Salanova and

Martínez, 2014). Adding onto the previous studies, my analyses in the exploratory study also suggest a meaningful relationship between resilience and performance.

5.5.3 Path Analysis

Following the regression analyses, the final step in the hypothesis testing, and also in the quantitative analysis, was to test the overall model suggested in section 4.6 by the research model and by hypothesis 7. This was done by combining the regression models proposed in section 5.5.2 and conducting a path analysis. Since SPSS Software does not have the path analysis feature, I used AMOS 23 to conduct this analysis. In this section, the results of this analysis are presented.

I used Path Analysis for two purposes: first to determine whether the model proposed to explain the overall relationship between certain team dynamics, team resilience and team performance is meaningful; and second, to understand the power and the direction of these relationships. Path analysis particularly allowed me in simultaneously testing the relationships I proposed and in demonstrating the relative importance of these relationships. The model fit indicators showed a complex story in terms of the overall fit of the proposed model. Therefore, further path analyses were conducted to test simpler models, particularly to demonstrate that the nature of the relationships in the complex model are very similarly manifested in the simpler alternatives. However, with the quantitative analysis, I could only test my research model partially as I could not collect quantitative data for all the concepts in the model. To investigate the relationships of the model that I could not test quantitatively, I utilized the qualitative data and include their interpretation in the Discussion chapter.

Main Research Models:

Combining the models of the regression analyses (section 5.5.2) forms the model in Figure 13 (*number of members* variable is excluded because of not having any significant relationship with *team resilience* or *profit/loss*; and the relationship between *team resilience* and *average grade* is also omitted because of being non-significant). However, based on the studies suggesting possible direct relationships between team dynamics and team performance (for e.g. Weick and Sutcliffe, 2007; Vessey and Landon, 2017), and in accordance with the results of section 5.5.1.4, which demonstrate significant correlations between precursor variables and team

performance, I also formed an alternative model, proposing additional direct relationships between team dynamics and team performance (Figure 14).

Considering the assumptions of Path Analysis, as demonstrated in the regression analyses the relationships between the variables are not significantly different from a linear form. In all alternative models, causal relationships point to single dimensions, hence, all are recursive models. Lastly, I applied the formula suggested by Foster *et al.* (2011b) for adequacy of sample and accordingly, sample size is found to be adequate.

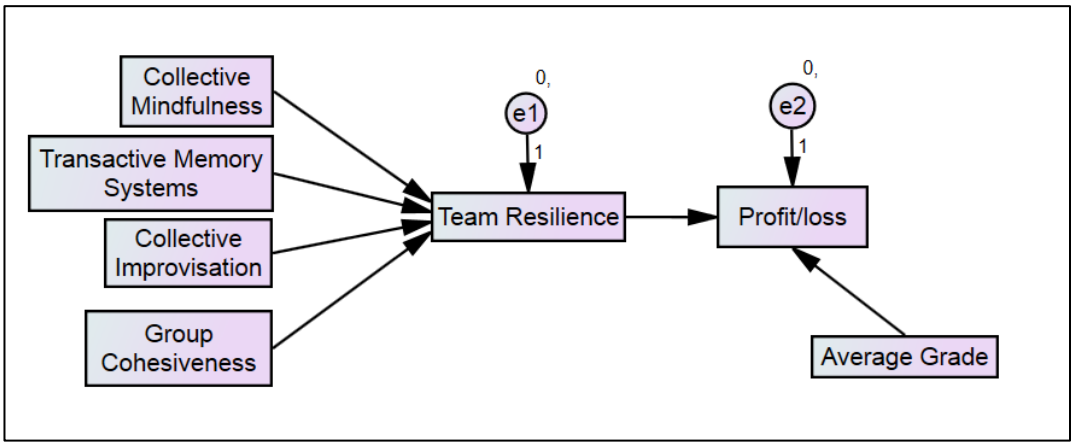

Figure 13. Path diagram for the overall model (covariances were not shown for simplicity), Model-1 n=47

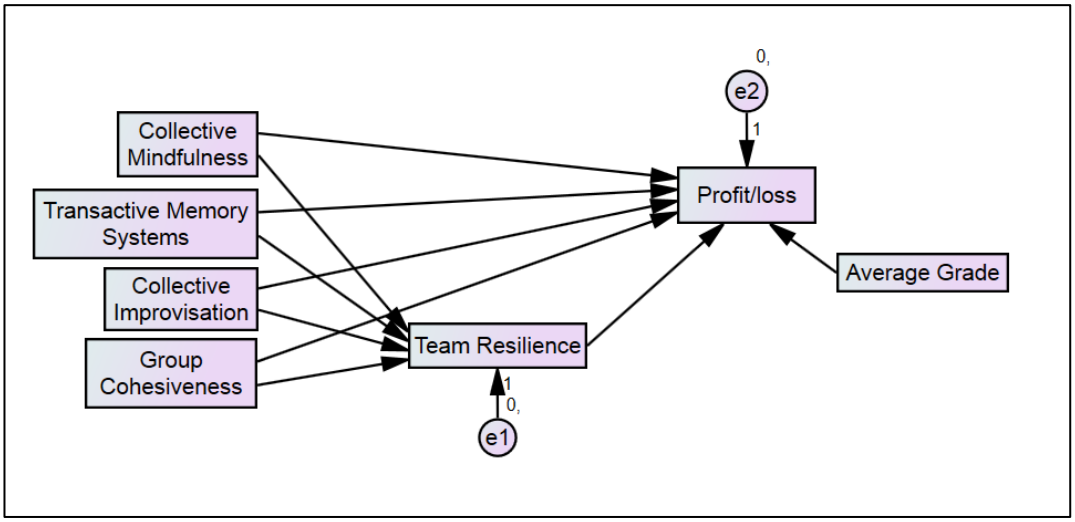

Figure 14. Path diagram for the overall model (covariances were not shown for simplicity) – Model-2, n=47

The overall model fit indices for the main research models yielded acceptable results. For both models, model chi-square is non-significant. The parsimony corrected fit (RMSEA) is above 0.05 for both models; however, PCLOSE values are also above 0.05 (non-significant) which means that RMSEA is not significantly different that 0.05. Hence, one may say that parsimony corrected fit is also at an acceptable level. The

absolute model fit is also at the acceptable level (with CMIN/DF below the threshold) for both models and the incremental fit indices yield satisfactory results.

Considering the estimates of Model 1, R^2 values for the dependent variables are very close to those found in the regression analyses; 0.81 and 0.43 respectively for *team resilience* and *profit/loss*. Except *team cohesion,* all the coefficients for the proposed precursors of *team resilience* are significant at the 0.05, with *transactive memory systems* having the biggest standardized effect. Moreover, *team resilience* is found to be significantly related to *profit/loss* and *average grade* is also found to significantly influence *profit/loss*. Overall, Model 1 validates the findings from the regression analyses.

	Main Models	
	Model 1	**Model 2**
	Standardized coefficient (significance level)	
Precursor variables for team resilience		
Collective Mindfulness	0.22 (0.03)	0.23 (0.02)
Transactive memory systems	0.47 (0.00)	0.46 (0.00)
Collective Improvisation	0.17 (0.03)	0.17 (0.03)
Team cohesion	0.17 (0.09)	0.16 (0.09)
R^2 for team resilience	0.81	0.81
Precursor variables for profit/loss		
Team Resilience	0.54 (0.00)	0.45 (0.03)
Collective Mindfulness	-	-0.02 (0.88)
Transactive memory systems	-	0.47 (0.02)
Collective Improvisation	-	-0.09 (0.52)
Team cohesion	-	-0.31 (0.05)
Control variables for profit/loss		
Average grade	0.23 (0.02)	0.21 (0.03)
R^2 for profit/loss	0.43	0.51
Overall Model fit statistics		
CMIN/DF	1.879	1.390
NFI	0.967	0.995
CFI	0.905	0.999
RMSEA	0.115	0.076
PCLOSE	0.153	0.277

Table 27. Path analysis results for the main research models, n=47

In Model-2, the R^2 for *profit/loss* has risen to 0.51 which is to be expected as four more independent variables were added to the analysis. Apart from these four new independent variables to explain performance, everything looks similar for these two models. Thus, better model fit may be attributable to adding direct explanatory links from precursors to *profit/loss*. When these direct links added, the standardized effect and the significance of *team resilience* on *profit/loss* decreased slightly but the effect is still significant and substantial. On the other hand, the standardized direct effects of the precursors suggest for meaningful direct relationship between operational performance and certain resilience precursors, namely, *transactive memory systems* and *team cohesion*. Hence, according to the results, resilience fully mediates the relationships between performance and *collective mindfulness* and performance and *collective improvisation*; it partially mediates the relationship between performance and *transactive memory systems;* and it does not mediate the relationship between performance and *team cohesion*.

Simplified Model:

Although the main models, particularly Model 1, validated the findings from the previous analyses and completed the hypothesis-testing, as mentioned before, there are several missing values for *collective improvisation* and *team cohesion* constructs, as they were not measured in the first two runs of the simulation. Hence, I examined an alternative simplified model where these two variables were omitted; to validate that the remaining results are robust; and valid when sample size is bigger (i.e. n=68). With this purpose, I proposed the model represented in Figure 15. Results from the simplified models are shown in Table 28.

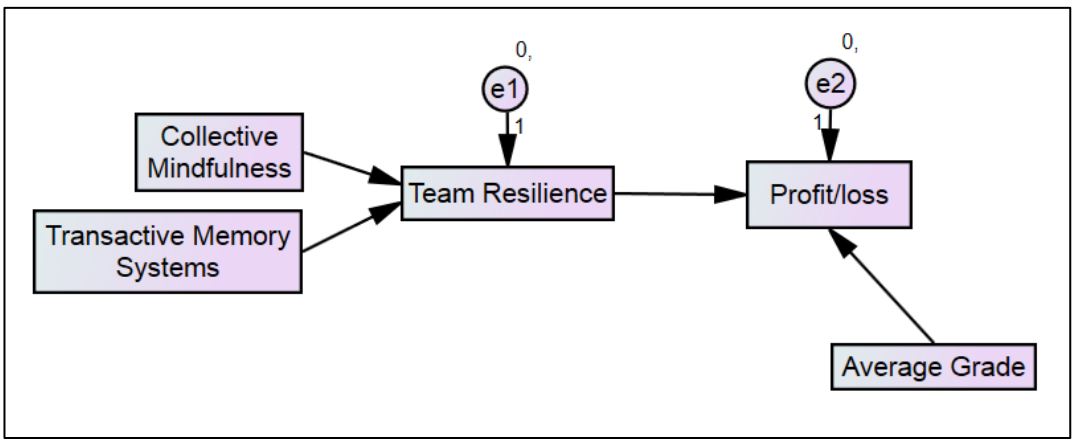

Figure 15. Path diagram for the overall model (covariances were not shown for simplicity) – Simplified Model, n=68

As seen from Table 28, in general, model fit indices yielded satisfactory results. The model chi-square is non-significant and absolute fit is obtained with CMIN/DF value below the threshold of 5. Moreover, both incremental indices NFI and CFI yielded very high values as they did with the complicated models. Lastly, parsimony corrected fit index RMSEA is above 0.05, however, PCLOSE values is also above 0.05 (non-significant) which means that RMSEA is not significantly different that 0.05. Hence, parsimony corrected fit is also found to be at an acceptable level. Provided model fit is acceptable, I examined estimates of the model. According to the results, the effects of *collective mindfulness* and *transactive memory systems* on *team resilience* are still significant when all participating teams are included in the analysis; and the effects of *team resilience* and control variable *average grade* on *profit/loss* are also still significant.

	Simplified Model
	Standardized coefficient (significance level)
Precursor variables for team resilience	
Collective Mindfulness	0.28 (0.01)
Transactive memory systems	0.64 (0.00)
R^2 for team resilience	0.77
Precursor variables for profit/loss	
Team Resilience	0.54 (0.00)
Control variables for profit/loss	
Average grade	0.23 (0.02)
R^2 for profit/loss	0.43
Overall Model fit statistics	
CMIN/DF	1.866
NFI	0.974
CFI	0.988
RMSEA	0.11
PCLOSE	0.187

Table 28. Path analysis results for the simplified models, n=68

Among all three alternative models, model fit indices yielded satisfactory results, in general. Moreover, on *team* resilience, the effects of *collective mindfulness, transactive memory systems* and *collective improvisation* are significant at the 0.05 level and the effect of *team cohesion* is significant at the 0.1 level. Furthermore, the effect of *team*

resilience on *profit/loss* is significant in all the models proposed. All these results validate that these relationships are robust and also observable when there are no missing values.

Hypothesis 7 guided the analyses conducted in this section. In accordance with this hypothesis, *team resilience* is treated as a mediator between certain team dynamics and operational performance of the team. This hypothesis was tested conducting path analysis using the operationalized research model. As for the two main model alternatives, the one with the direct links from the precursors to team performance was found to be a more meaningful model with better overall acceptability statistics. This suggests that the precursors, particularly *transactive memory systems* and *team cohesion*, whose direct effects were significant, might also be directly affecting performance as well as effecting it through team resilience.

In all three models tested, *collective mindfulness* and *transactive memory systems* are found to be associated to *team resilience*; and *team resilience* found to be associated to *profit/loss*. When involved in the model, *collective improvisation* is found to be significantly effective on *team resilience*; and this result contradicted to the regression analysis results while confirming the correlations analysis results. Regarding the relationship between *team resilience* and *team cohesion*; path analysis confirmed regressions results and suggested non-significant effects at the 0.05 level (p-value is 0.09). As mentioned above, when direct contributions from precursors are tested in explaining *profit/loss*, only contributions of *transactive memory systems* and *team cohesion* are found to be significant. Finally, R^2 for *team resilience* changes between 0.77-0.81; it is affected slightly by the exclusion of *collective improvisation* and *team cohesion* from the model. R^2 for *profit/loss*, on the other hand, changes between 0.43-0.51; it is it is affected moderately by the exclusion of the direct effects of team dynamics.

Interpreting the results with regard to hypothesis 7: *team resilience* partially mediated the relationship between *collective mental models* and *operational performance*; fully mediated the relationship between *collective improvisation* and *operational performance*; and does not significantly mediate the relationship between *team cohesion* and *operational performance*. Overall, hypothesis 7 is partially confirmed with the partial validation of the mediatory effect of resilience between team dynamics and operational performance.

5.6 Conclusion

The purpose of this chapter has been to present the findings from quantitative analyses described and explained in the Methodology chapter. Using various quantitative analysis techniques, I tested the relationship between resilience, its antecedents and its outcomes as proposed in my research model and in line with the hypotheses I formulated. As a result of these analyses, *team resilience* is found to be strongly related with *collective mental models*. Moreover, there is evidence for the positive relationship between *team resilience* and *collective improvisation* and between *team resilience* and *team cohesion*, although some of the complex analyses suggested these relationships might be non-significant. Lastly, according to the quantitative analyses, the hypothesis with regard to the relationship between *team resilience* and *team potency* were not supported. Nonetheless, qualitative data provided additional insight with regard to all these relationships.

Following the quantitative findings chapter, in the qualitative findings chapter, the model is further explored with the utilization of qualitative findings. These qualitative findings are in the form of anecdotes, either observed by the researchers of the parent project (including myself) or told by the participants, and they demonstrate the manifestation of the relationships proposed in the methodology. In addition to supporting the finding from the quantitative analysis, I also used these qualitative data to explore the parts of my research model that I could not test with the quantitative data; and to discover new relationships that I did not include in the initial model.

6 Results 2: Qualitative Findings

6.1 Introduction

In this chapter, I present and interpret my findings from the qualitative data. I utilize qualitative data with three purposes. First, I validate and elaborate the quantitative findings. With the help of qualitative data, I illustrate the relationships validated with the quantitative data and offer explanations for the relationships that were not validated. These illustrations and explanations help to understand the mechanisms that may underpin and explain these relationships. I provide illustrations and explanations that elaborate on the quantitative findings in chapter 6.2. Second, I seek evidence from the qualitative data for the relationships of my framework that I could not test with quantitative data. Because of the trade-offs made in the selection of quantitative data tools, I could not collect quantitative data on certain attributes in my framework. I therefore utilize anecdotal data from direct observations and participant reflections to investigate these relationships. Section 6.3 articulates the results of this work. Thirdly, qualitative data were also useful in my study in terms of revealing mechanisms that were not included in my research model but which emerged in the course of the research as apparently significant for resilience and performance. I provide discussion with regard to these relationships in section 6.4. The events which I refer to during the qualitative investigation were either directly observed by myself (or by other researchers), recorded by on video, or revealed by the teams during the strategic review meetings or post-trading presentations.

6.2 Further validation of the quantitative findings

In this section I will elaborate on the key findings from the quantitative analysis, using the qualitative data. The main purpose of this elaboration is to explore the mechanisms of the relationships revealed by the quantitative analysis and to illustrate and provide examples of specific activities and processes within the teams.

6.2.1 Team resilience and collective dynamics

The first five hypotheses that guided the quantitative analysis were related to the relationship between team resilience and certain collective dynamics. Correlational results provided initial support for hypotheses 1-4, based on precursors identified in

the literature review and exploratory study. Thus, strong and positive relationships were expected between resilience and: *collective mindfulness* as proposed by Maynard and Kennedy (2016) and demonstrated by Weick (1993); *team transactive memory systems* as proposed by Bowers *et al.* (2017); *team cohesion* as demonstrated by Morgan *et al.* (2015) and Vera *et al.* (2017); and *collective improvisation* as proposed by Sutcliffe and Vogus (2003) and Boin and McConnell (2007) and demonstrated by Weick (1993) and Kendra and Wachtendorf (2003b).

Regression analysis further supported hypotheses 1 and 2, providing strong support for the relationship between resilience and collective mental models. Both *collective mindfulness* and *transactive memory systems* measures were used to explore this relationship; and both provided support. Qualitative data reinforced this. I observed that several teams detected problems by establishing a shared and constantly updated cognitive map of the operational environment. They also formulated solutions to the challenges that they faced using information stored in this collective map. For example, when reflecting on their experience after the trading period, Team-11 stated that when they faced problems, they collectively discussed how to approach to solve them in order to utilize the skills and knowledge of each member, and they made sure that each member had the same understanding with regard to the operational conditions. Team-11 added that they generated this collective capacity by constantly interacting among each other; by establishing a common vocabulary; and by gathering information from the operational environment.

In another example, Team-2 revealed that they initial planned to try to complete 22 orders (the average number of successful orders is 10 and average number of delivered orders is 13). However, they later reduced this number to a more reasonable target by updating their collective mental model of what was possible by practicing rigorously and by collecting feedback from the controllers. This prevented them from putting extra stress on themselves by trying to achieve a *nearly impossible* goal.

On the other hand, the results of the regression analysis were unexpected with regard to the rejection of hypotheses 3 and 4. In the literature, team cohesion is related to resilience (West, Patera and Carsten, 2009, p. 259). Moreover, analysis of the exploratory study also indicated the importance of being unified and working collectively and harmoniously in accomplishing mutual goals and addressing

challenges. Hence, I expected *team cohesion* to be significantly related to *team resilience*.

The qualitative data also support the existence of this relationship. Many resilient teams mentioned the importance of "mutual objectives" (Team-3), "mutual understanding" (Team-1), "mutual purpose" (Team-4), "strong team identity" (Team-7, Team-16 and Team-5), and "collective identity" (Team-11) to addressing and overcoming problems. They particularly drew attention to how this sense of unity prevented the possibility of social loafing and made each and every member feel responsible for their collective actions. They also mentioned that unity facilitated the establishment of *shared mental models* and decreased the possibility misunderstandings that might lead to harmful conflicts. To further improve this unity, several teams created mottos and even ordered and wore custom-printed team T-shirts on trading day.

In contrast, there were teams that could not address challenges efficiently because they could not work cohesively as a team. For example, Team-67 accounted for their avoidance from the possibility of conflicts and admitted that this created "silos". In the preparation phase, the team split into sub-units and practiced separately with very weak communication in-between sub-units. The lack of necessary interaction continued during the trading period and because of this, they were not able to coordinate individual efforts while trying to respond to challenges.

Moreover, some teams experienced harmful conflicts because of their inability to establish strong team unity. For example, in Team-59, some members wanted to start the trading period with easier orders to ease the initial adjustment whereas others wanted to start right away with the most profitable orders. This caused some team members to interfere with the tasks of the order-taker and in turn harmful conflicts arose among the team members. This led to a general demotivation within the team and slower response to other challenges that they faced because of the attention paid to the conflicts. These examples advised for a positive relationship between *team cohesion* and *team performance*, which is also the result of the quantitative analysis. However, this result is not found to be statistically significant.

Furthermore, improvisation has been proposed (Sutcliffe and Vogus, 2003; Weick, Sutcliffe and Obstfeld, 2008) and found (Weick, 1993; Kendra and Wachtendorf, 2003b; Boin and McConnell, 2007; West, Patera and Carsten, 2009) to be one of the key

facilitators of resilience. It also correlates with team resilience using bivariate correlation analysis. Therefore, the finding with regard to the superficiality of the effect of improvisation on resilience is also rather surprising.

The qualitative data provides a few idiosyncratic examples of times when teams were effectively able to improvise in response to a challenge. For instance, Team-6 took a 12-card order from the order board and realized that they only had 8 sheets left of that colour. They did not have time to buy sheets (as there was a 10-minute lead time for material orders). They then did something that they had not planned: they reached out to the other teams to try to buy sheets from them, which, indeed, they succeeded in doing. They in fact bought sheets from a team for a price that was much cheaper than the controllers offered. They were able to finish the order by the deadline to the required quality standards. In another example, Team-10 had an order rejected early in the trading period. They quickly re-arranged their production organization, adding another quality control point to the card production process, a control point on which they had not originally planned. They went on to be the only team that made a profit in that simulation.

Nonetheless, there are not many examples of teams being resilient and/or performing well because of effective improvisation. There are even teams that were successful in spite of showing little *improvisation*. For instance, Team-12 suggested that one of the reasons behind their success was intensive pre-trading practising and modelling so that they did not need to leave room for unanticipated events; and hence, they were able to perform well even though they did not display an ability to improvise in the course of the trading. Similarly, Team-31 also described how they sought to reduce unambiguity and clearly define roles and processes in order to avoid having to *improvise* during the fast-paced atmosphere of the trading period. Hence, it appears *collective improvisation* is important to *team resilience* when teams face unexpected challenges. The more a team is able to model the possibilities of the challenging environment, the less improvisation is needed to be resilient. On the other hand, effective improvisation seems to be an important precursor of resilience when teams are faced with unexpected challenges.

With the path analysis, direct relationships between collective dynamics and team performance were also tested, particularly to understand the nature and the strength of the mediation effect of team resilience. Surprisingly, the direct effect of *team cohesion*

on team performance was negative. Regarding this, previous literature suggests that excessive desire for cohesion may lead individuals favour conformity in order to avoid conflict, and this may lead to ineffective decision-making (Maynard and Kennedy, 2016, p. 42). This was also evident in the qualitative data. With the purpose of avoiding conflicts, Team-54 developed a culture that did not welcome questioning and challenging of others' positions and ideas. Hence, no proposition was challenged explicitly and during the trading period it became clear that some previous decisions had not been unanimously accepted. Even during the trading period, this realization did not turn into conflict, but rather created a deepening sense of isolation between group members. In order not to upset other team members, decision alternatives were never expressed. Even the negative (but vital) feedback of the controllers about why cards were not meeting the quality standards was not relayed to other members of the team. Team members admitted "barely" communicating with each other during the trading period and just using words like "yes", "no", "here", etc. The team did not make a single adaptation to their production process in response to multiple rejections of orders, which contributed to their very poor overall performance.

In relation to the 5th hypothesis, *team resilience* is not found to be significantly correlated with *team potency*. This means hypothesis 5 is rejected. It was unexpected to see that *team resilience* was not significantly correlated with *team potency*. *Team potency* has been proposed to facilitate resilience both at the individual level (Lewis, Donaldson-Feilder and Pangallo, 2011, p. 3) and at the team level (and Sutcliffe and Vogus, 2003; Lengnick-Hall, Beck and Lengnick-Hall, 2011; particularly in the form of 'self efficacy' by Bowers *et al.*, 2017). From the findings from my exploratory study, which found support for the suggestions from Sutcliffe and Vogus (2003, p. 102) and Vera *et al.* (2017, p. 128), I expected potent teams to respond more confidently to challenges, and therefore , in turn, be more resilient in their responses. I expected potent teams to remain confident and calm in the face of adversities and thereby increase the chance of utilizing their behaviour repertoire.

Of course, if potency is not backed up with a rich and robust behaviour repertoire, it may not lead to resilient responses, but simply to hubris and rash, possibly inappropriate actions. This distinction between potency and team capability may thus explain the lack of relationship between potency and resilience. In the strategic review meetings prior to the trading period, I observed signs of potency in both high performance and low performance teams. For instance, the worst performing team of

all runs of the simulation (Team-68) and one of the best performing teams (Team-2) both scored highly on potency. The difference between these two teams was easily recognisable through investigation of the qualitative data.

Team-68 had several errors in their financial plan (and were warned about these by the controllers prior to the trading period, something which is quite unusual). They did not diligently examine the product specifications and rules of the trading period (for example, they thought that they would be paid for late orders) and they did not engage in much practice production. On several occasions, they were unable to complete orders within the deadline. When faced with adversity during trading (e.g. rejections), they did not have the necessary cognitive resources (e.g. knowledge) to overcome it. On the other hand, Team-2 had a viable team structure with clear roles defined according to their perceived strengths and weaknesses, had a rigorous quality control system with effective, rapid double-check mechanisms, and engaged in intensive practice and modelling in the preparation phase. In fact, they were so aware of and confident in the accuracy of their strategy that they sacrificed several minutes during the trading period by waiting for their preferred orders (i.e. profitable) to appear on the order board. During the trading, every idle second could better be spent by producing more cards to earn more profits; hence, only a team with a strong belief in its decisions and capabilities could risk losing time to obtain more profitable orders.

Another reason for this unexpected result might be the point at which *team potency* was measured, which was before the trading period. As elaborated in the following section, the relationship between resilience and performance may be cyclical rather than linear, and in such a cycle, increased performance may reinforce team potency, and this, in turn, may facilitate resilience. Team potency was not quantitatively measured during or after the trading period, so this proposition cannot be tested with quantitative data.

Team potency also did not correlate significantly with almost any of the performance measures. The moderate relationship between *team potency* and *cards delivered per person* is an exception to this; and this could be attributable to the suggestion that potent teams, with or without paying attention to the accuracy of their production, might be more motivated towards achieving high production levels. This might be reflected in their productivity levels; however, it would only be reflected on the quality

if they had a good understanding of the specifications and a well-established quality control processes.

Although not strongly supported by the quantitative analysis, the qualitative data suggest a mechanism for the relationship between resilience and operational performance where *team potency* is involved. According to this mechanism, increases (decreases) in performance boosts (lowers) potency, and, in turn, enhances (diminishes) the effectiveness of challenge-response process. For instance, Team-36 described how the news of the rejection of their initial order lowered their belief in their abilities, and this, coupled by increased stress levels, impeded their problem-solving abilities. This mechanism could not be tested using the quantitative data as quantitatively *team potency* was measured before the trading period.

6.2.2 Team resilience and team performance

Overall, the relationship between resilience and performance is validated by the correlation analyses, which provide initial support for hypothesis 6. Reinforcing this, the results of the regression and path analyses also suggested a meaningful and strong positive relationship between team resilience and team performance. Thus, one may conclude that for teams operating in the challenging environments, resilience is associated with better performance results. Resilience scholars have argued that performance can be both conceptualized (Pulley, 1997; e.g. Reason, 2000; Sheffi, 2005) and empirically examined (e.g. Gittell *et al.*, 2006; Gomes *et al.*, 2014; Jaaron and Backhouse, 2014) as a natural outcome of resilience. I, too, have adopted this view in the establishment of my research model.

Nonetheless, my observations from the simulations also support a two-way interaction between resilience and operational performance. The ability to address and overcome the challenges of the operational environment allows teams to concentrate on producing quickly, accurately and efficiently. Moreover, it encourages teams to aim for difficult, high-value orders, and delivering them contributes further to the performance. However, increased performance also facilitates resilience to forthcoming challenges in the form of boosting potency and reducing stress. Conversely, when performance decreases experienced, most prominently observed with *rejections*, teams' stress levels increase and their belief in their abilities weakens; and this, in turn, diminishes their effectiveness in addressing and overcoming of subsequent challenges. For some teams,

this creates a snowball effect, where the inability to overcome several small challenges leads the team into a major crisis.

The qualitative data also suggest the existence of such relationship. Testimonials from the teams show that almost all teams went through challenging and stressful times one way or another during the trading period. The ones that were able to overcome them and maintain production despite these challenges were the ones that performed the best. For instance, Team-6, which was the winning team of their simulation, in fact could not deliver their first order because of an unexpected error they made (the wrong templates were used). This did not make them feel depressed, on the contrary, they became more motivated towards performing better.

Team-5 also stated that they experienced very stressful time, adding that instead of feeding the stress, they chose to back off from the process and tried to understand the big picture. They claim that doing this was why they were able to 'keep it cool'. On the other hand, teams which could not overcome challenges and were caught by negative effects tended to be drawn into vicious cycles of demotivation, denial, depression and/or blaming and in turn were the ones that performed worst.

One of the worst performances among all the teams belonged to Team-67. A primary reason for this was their inability to pull their team together after the loss of a pen early in the Game. A pen is an important piece of equipment (costing £300). However, the team could have purchased a replacement. Instead, they became preoccupied with what caused this loss, which, in turn, prevented them from overcoming the adversity that they faced. "I was writing [i.e. producing], but at the same time I was thinking 'my god, what happened to the pen?'".

Another striking example was Team-68 which had three orders rejected and seven orders unfulfilled, which clearly shows that there were significant issues with their ability to take, produce and deliver orders on time and to the specifications. However, instead of processing the feedback they were receiving from the Controllers and focusing on generating viable solutions to the problem, the team went into a cycle of denial. This shows their inability to establish accurate awareness of their circumstances and take corrective action.

6.3 Further exploration of the research model

This section focuses on the relationships between resilience and its proposed antecedents as well as the relationships between resilience and performance; and elaborates on the mechanisms of these relationships. As demonstrated in chapter five, the hypothesised relationships between resilience and certain team attributes proposed as antecedents were tested by the quantitative analysis. However, I was not able to collect quantitative data for all the propositions in this model. Hence, I used qualitative data, first, to elaborate on the relationships revealed by the quantitative analysis and, second, to investigate the relationships that could not be investigated through quantitative analysis. The qualitative data also revealed some new relationships that were not part of my original research model.

In this section, I explored the relationships between resilience and its proposed precursor that I could not test quantitatively; and I also elaborate on how these relationships contributes to operational performance. In general, I noticed that although individual traits and skills of team members are important in addressing challenges and adversity, teams' collective dynamics play the key role in resilient responses; these collective dynamics are not just merely an aggregation of members' individual skills. The themes discussed below elaborate on how these collective dynamics pave the way for resilience, and, in turn, contribute to maintaining of satisfactory performance.

6.3.1 Knowledge accumulation (preparation, modelling, testing and trials)

Although not directly tested by quantitative data analysis, an important precursor of both being resilient and performing well is proposed to be collective knowledge accumulated prior to operations. In the simulation of my main study, such knowledge arose from the work done by the teams in the preparation phase. As detailed in the methodology chapter, teams have around one month from when they form until the trading day. They have a great deal of flexibility in how they can utilize the time allowed for the preparation; and hence, what is done in this period causes significant differences among the teams. The work done in this period is particularly important for the development of accumulated knowledge; which, in turn, broadens the action repertoire utilized to address and overcome challenges.

Various choices are made by the teams. These include how many times the members will meet, how long the meetings will last, how many members are present in various

meetings, how much individual and collective practice members will carry out, etc. and these decisions influence the simulation outcomes. However, in addition to these basic decisions, and possibly more importantly, teams also make decisions with regard to specific preparation actions. There is certain generic work that has to be carried out. All teams have to define their mission, generate strategies to achieve that mission, organize their team around the strategies and develop the necessary skills. The strategic plan that they must submit requires them to do this in a form that can be scrutinised by others. However, with differences in the preferred approach to this work, teams build different structures and capacities. According to my direct observations and my examination of participant reflections, I identified the approaches discussed below as those that showed significant differences among the teams.

6.3.1.1 Effective strategy forming

In order to be able to make profit, let alone being the best performing team in the simulation, teams need to successfully understand the types of orders to select from the order board. This requires a thorough understanding of the financial dynamics of the trading period, because the profitability on certain types of orders (for instance, large, open-ended orders) is so low that it is impossible to cover the outgoings with these orders, even if all such orders meet the quality criteria. On the other hand, aiming for the most profitable orders might not be the best strategy for all teams. For instance, if a team cannot produce the most demanding, but highest profit orders of 12 cards in 15 minutes, then taking this type of an order from the order board would only bring losses. In another example, if a team has two writers with extremely different writing styles, then taking a 12-card order is a risk since it could be rejected on the grounds of insufficient consistency in the writing; so, a less risky strategy may be to take two 4-cards orders that are produced on two production lines. However, even adequate understanding of financial dynamics and team capabilities is not enough to guarantee the best strategy, as competition for orders at the order board is extreme. At a particular point in time, there might be several order-takers from different teams that are all pursuing similar strategies; and hence, they might all be seeking similar orders in front of the order board. Thus, first, the order taker has to be able to manage the first-come-first-served (in this instance: first-called-first-served) principle of the order board; and, second, alternative strategies have to be formulated in case the order taker cannot obtain the desired orders.

In this sense, effective strategy forming is about coming up with optimum strategies to best serve the ultimate purpose of the team, which is to be a profitable team in the context of the simulation (or to be "the most profitable team" or "to win the game" for most teams), while at the same time considering the limits of team capabilities in the face of the dynamics of the trading period. The latter is extremely important, because this is the point at which effective strategy forming facilitates team resilience. Strategies that are not compatible with a team's capabilities or those that do not consider trading dynamics are the ones that can pave the way to adversity. Alternative strategy forming may then be required to address these adversities or other challenges faced during the trading period.

One of the best examples of this could be seen with Team-6. They were a very confident and skilful team, successful at producing the most profitable orders to the specifications. They were effective in obtaining these orders from the order board and they strategically appointed an order taker with a careful eye to quickly detect such orders and a powerful voice that could easily be heard by the controllers. In addition to this, the order-taker constantly monitored the order board and detected profitable orders. He advised the team's inventory manager accordingly who acquired the necessary materials and then obtained these orders from the order board. In this way, the team were able to overcome the problem of losing the desired orders to other teams.

Another example is Team-2 who also formed their strategy around the most profitable orders. They encountered a situation in which for a while there were no orders on the order board that fulfilled their order selection criteria. Team-2 was sufficiently confident of their understanding of the financial dynamics of the trading period that they knew they should only take high value orders. Consequently, they allowed their production lines to stand idle for more than 10 minutes waiting for the right type of order to appear on the order board. In the context of the trading period this is a very difficult thing to do, and most teams start to more-or-less randomly take orders under these conditions, However, Team-2's effective pre-trading strategizing activities helped them to make the correct decision and their potency (particularly with regards to the strategies they formulated) allowed them to implement it.

6.3.1.2 Effective planning

The qualitative data suggested *effective planning* as another important source of knowledge accumulation, as, in the planning process, teams decide what to focus on in the development and utilization of their action repertoire. The concept of broad action repertoire has been investigated in the resilience literature, and sometimes referred as *resourcefulness*. It is proposed (Hamel and Valikangas, 2003; Lengnick-Hall and Beck, 2005) and empirically demonstrated (Furniss *et al.*, 2011) as one of the antecedents of resilient responses. Effective planning helps teams to decide how best to utilize this existing action repertoire and when to deviate to improvised actions.

In the simulation, four important elements of *effective planning* help teams to best utilize their action repertoire. First, teams have to develop a plausible plan, which should be both realistic and applicable considering the nature of the environment and the capabilities of the team, and it should be built upon information collected and validated rather than on arbitrary or tenuous assumptions. For instance, while building up their plan, Team-4, the winner of their simulation, rigorously tested their production line. They first tried two production lines, each with one stenciller and one writer, but observed that the stenciller became the bottleneck. Then, they tried a single production line, where three members stencilled and one member wrote verses. This time the stencillers became idle sometime during the process; also, three stencils were considered to be a costly investment. The team agreed on one production line with two stencillers and one writer after a final trial. The results of the simulation demonstrated how such rigorously tested, information-based plans can work out well.

Conversely, Team-59, admitted that their planning was based on faulty, untested assumptions which caused their plan to crash during the trading period. After feedback from the controllers during their strategic review meeting that the team were overestimating their capacity, they amended their plan according to untested assumptions about lower capacity, but not based on capacity-testing. They were thus no closer to understanding what their true capacity was. Similarly, Team-68, also built their plan on an overly optimistic assumption regarding their production capacity and took out a massive initial loan. The team's inability to fulfil the high-profit hard-to-make orders resulted in the **biggest loss** among all 68 teams.

In another example, Team-31 did their planning based on trials, however, they had not considered the negative effect that challenging conditions of the trading period might

have upon their production levels. They did not consider the alternative and more flexible option of purchasing more material during the trading period; instead they bought all the materials they thought that they would require for their anticipated 35 orders (which was an extremely optimistic forecast, considering that the average number for orders fulfilled by all 68 teams is 12.8 and the maximum is 22). This, in the end, left them with a huge amount of unused materials which depreciated significantly, thus condemning them to a loss.

The second element of *effective planning* lies in making contingency plans. One of the most important recurring issues in the poor-performing teams is the collapse of the plan during in the trading period due to a gap between expectations and reality and the lack of any contingency plan in case the original plan runs into difficulty. Unexpected adversity is one of the biggest obstacles to performance, and one of the hardest to deal with for teams that do not plan how to respond to it beforehand. Therefore, teams will be more resilient if they conduct scenario analyses during the preparation and develop contingency plans accordingly.

I argue that this is one of the mechanisms of developing *collective mindfulness* by collectively generating and agreeing on alternative solutions to possible errors and problems; and integrating these solutions (and the ways to implement them) into the plans for collective action. I found *collective mindfulness* to be related to *team resilience* in the quantitative analysis. Moreover, this is also demonstrated by the qualitative data, as a majority of the low performing and low resilience teams stated that they had not considered alternatives to their expectations of the trading period or planned in accordance with these. Team-36, for instance, had not envisioned that the Controllers would have templates to measure the centrality of the verses and therefore did not think that they needed to be precise about centring. That ignorance caused their initial production to be rejected. They were not expecting this adversity and were unprepared for it, hence it was followed by more adversities such as unbearable work pressure and intra-team conflicts and communication gaps, leading the team to unsatisfactory performance in the end.

Similarly, Team-54, Team-63 and Team-53 were among the worst performing teams and all mentioned how **not having a contingency plan** left them unprepared for the challenging conditions of the trading period. Because of this, they could not formulate resilient responses to these challenges, and in turn, they could not provide satisfactory

performance. Conversely, a majority of the high-performance teams (e.g. Team-1, Team-16 and Team-2) all described how they conducted scenario analyses prior to the trading period, generating alternatives to their original plan and applying them when their original plan did not work.

A third element of *effective planning* is the ability (and maybe also the courage) to deviate from the original plan when necessary. This is mainly about fighting against tendencies towards rigidity. Sutcliffe and Vogus (2003, p. 107) proposed rigidity as the reason behind the 'negative adjustment' under challenging conditions. In the trading period, rigidity is mostly exercised by the low performing teams. For instance, Team-68 insisted on going after high-end orders even though they did not have the capability to produce them in time and to the specifications. However, even high-performing teams could find it hard to abandon a plan that had served them well up to that point. For example, Team-16 delivered effective performance until the last 30 minutes of the trading period. At that point there were no orders left on the order board that matched the team's inventory, which consisted only of the particular colours they planned to produce from the very beginning. At that point, instead of purchasing other colours to match the orders on the order board, they 'stalled', waiting fruitlessly in front of the order board for the desired type of orders to appear, which did not happen. Here the rigidity of their plan, which served them well for most of the trading period, suddenly became a liability. The team still did well, but not as well as they might had they been more flexible in terms of 'letting go' of the plan when circumstances required it. Some high-performing teams demonstrated an ability to deviate from their plans when it was necessary; such as Team-12; when they realized they were capable of producing high-end, difficult orders they started taking them from the order board, despite not having originally intended to do so.

Finally, a team needs to be able to know when to stick to its plan and when to deviate from it. This is called an **ambivalence capacity** towards balancing uniformity and deviance and deciding which one to follow based on the information available. This has been proposed by Weick (1993) as a facilitator of resilience. This is also about the ability to prevent unnecessary and harmful deviation, which is where most low-performing teams experience problems. For instance, what many low performing teams do when they encounter unexpected conditions is to (often unwittingly) change their organization and role structure as members try to respond to the situation in ad-hoc ways. It is extremely hard for members to adjust to roles for which they had not

been trained, which often results in more issues (production mistakes, miscommunication etc) creating even more problems. Low performance usually follows. Conversely, successful teams typically analyse their situation before acting and hence, understand when a deviation is beneficial or harmful. For instance, during the preparation period, Team-4 realised that their order taker was getting stressed about making improvised decisions with regards to which order to take. The team anticipated that this stress might prevent her from securing the appropriate orders. Hence, they prepared detailed order selection guidelines for her, which she conformed to until the end of the trading period.

6.3.1.3 Effective specialization and organization

A third precursor of resilience, which is rooted in the preparation phase, but effective throughout the trading day, is effective specialization and organization of team members. As mentioned in detail previously, there are several different tasks that need to be fulfilled (simultaneously, more often than not) throughout the trading period in order for a team to make profits. The order board has to be monitored; strategically important orders have to be secured; the order-takers must communicate with the production team and orders produced in accordance with a set of strict criteria to a strict deadline; and then submitted to the controllers. In the meantime, constant stock and quality control have to be carried out, along with monitoring of the overall 'system' to make sure all the tasks are accomplished efficiently and without member burn-out. It is near-impossible to maintain this cycle of tasks without proper specialization, particularly in the face of the fast-paced atmosphere where every second counts. Specialization is also proposed as an enabler of resilience and performance in the previous resilience literature by various researchers (Vogus and Sutcliffe, 2012; e.g. Richtnér and Löfsten, 2014). Resilience researchers also proposed specialization as a solution to prevent "cognitive overload" (Levinthal and Rerup, 2006, p. 506). In the simulations, I observed that many high-performing teams prioritize specialization in the preparation period; and they mainly allocate roles in accordance with strengths and weaknesses rather than a random allocation. In their reflections, these team account for the practices they execute to make the most efficient specializations. For instance, Team-11 stated that while allocating roles, everyone tried to fulfil the roles and the roles were assigned to the best performers.

On the other hand, extreme specialization, where certain members are the only ones equipped to carry out their specialized roles and do not know about or monitor the

work of other members is also problematic. Errors are less likely to be spotted in time, and worse, no-one can (skilfully) fill in for other members when adjustments are required. In this case, if a member is fatigued or ineffective for some other reason, the tasks s/he is supposed to perform cannot be accomplished and the cycle is broken. In previous studies of resilience, researchers stressed the problems that specialization may cause with regard to limiting flexibility (Bigley and Roberts, 2001, p. 1281) and reducing slack resources (Winn *et al.*, 2011, p. 169). Therefore, in the challenging and dynamic operation conditions of the trading period, teams need to *effectively* specialize, which means that every member is trained to be expert of a particular task set, and at the same time, in some way, all members should be replaceable. This is also seen in the quantitative data. One of the dimensions of the *transactive memory systems* measure is **specialization** and it is found to be significantly related to *team resilience*.

There are various ways a team can effectively specialize and organize to be resilient and successful in the trading period. For instance, in Team-9, all the members except one specialized in a particular set of tasks and one member, called the *floater*, trained to fill in for any task if needed. The team stated that knowing that extra help was available all the time boosted their confidence and safe-guarded them against the "stressors" of the trading period. With a similar purpose, Team-31 assigned a "jumper" (as they named the position) to avoid work overload. In another example, in Team-2, each member on the production line was trained in two roles (e.g. folder, stenciller, writer, etc.) so that if high workload became an issue during the trading period, a less loaded member could effectively provide help. Similarly, Team-11 started allocating members to specific roles, but conducted "cross-training", to make sure members could take breaks if needed. All these extra capacities served as flexible resources to enable functions to be fulfilled despite uncertain conditions.

In line with specialization, different organization styles emerged in different teams. For instance, teams that assigned "floaters" generally preferred single-line production where the floater could fill in for others on the line. Conversely, teams that conducted "cross-training" generally preferred two-line production units, where two orders were normally carried out at the same time, but when required cross-trained members could fill in for one another allowing everyone to work on a single order.

How a team decided what roles to assign to which member was at least as important as the *effective specialization* described in the previous paragraph. Clear patterns were

observable among the high performing and low performing teams with regard to this. While high performing teams spent substantial amounts of time during the preparation phase in order to allocate roles appropriately and pay attention to strengths and weaknesses, low performing teams generally allocated roles according to initial preferences and never went back to question their appropriateness. In high performing teams, roles were typically clearly defined (demonstrable by the strategic review documents submitted) and assigned according to strengths and weaknesses, skills, talents and abilities. These teams generally tested various roles for different members and assigned roles to the most appropriate individuals. Conversely, low performing teams did not pay as much attention to role clarity and roles assignment based on the assumption that if an individual wanted a role, then s/he would be successful at it. When faced with the reality of the trading period, roles could not be filled competently and this sometimes brought strategy collapse and quality problems along with it. Members would start to change roles or some would assume extra roles that they could not properly fulfill.

For instance, a member from Team-63 stated that s/he started the trading period as an order taker and submitter, but during trading s/he also needed to do stock control, purchasing and communication work and that this created overload resulting in stress and decreased productivity. Similar problems was obvious in Team-67 as well. Their problems started with the way that they assigned roles. Initially roles were not defined clearly to individuals and some were not clear about the specific tasks that their roles comprised. Second, tasks were defined independently of each other and the connections between them were omitted - this impeded cohesion during execution. Moreover, when the team started to face adversities (such as rejections and the loss of a pen – a crucial produciton resource), members immediately started to switch roles, possibly because of an existing lack of fit between individuals and roles. However, this impulsive switching further reduced resilience, because members could not adjust to their new roles and struggled to accomplish their new tasks.

6.3.1.4 Rigorous training and practicing

We have seen how, in order to perform satisfactorily in the simulation, teams needed to be aware of their skills and competences and to form their strategies accordingly. However, this is not quick and easy to do on the basis of a single trial. Once a team decides in what configuration (i.e. organization) of the team is most productive, it must practice if it wishes to be able to target the most difficult and profitable orders. A team's

skill set is identified as one of the most crucial precursors of resilience in the previous literature in the form of "slack capabilities" (Sutcliffe and Vogus, 2003, p. 107), "learned resourcefulness" (Lengnick-Hall, Beck and Lengnick-Hall, 2011, p. 246), and "competence" (Horne and Orr, 1997, p. 32).

It is also evident from the qualitative data that an enhanced skill set increases teams' resilience, as it facilitates the maintenance of normal performance levels when simultaneously dealing with challenges. Teams that develop skills to produce accurately and quickly can continue their production while simultaneously addressing challenges. Consequentially, the teams with enhanced skill sets tend to be the best performing teams of the simulation. For instance, Team-2, which obtained the second-highest profit among all 68 teams, stated that they met 11 times to practice production as a team, excluding strategy and planning meetings and individual work. They also stated that because of this rigorous practicing they were able to continue their production in the face of the "stressors" of the trading period: unfavourable work conditions such as crowded conditions, "rushing and shouting people", "happy screams of competitors to the accepts they get", "whistles blown by the controllers when a team got rejected", etc. coupled with market uncertainty and time pressure. Team-9 also stated that the emphasis they placed on pre-trading practice allowed them respond to unpredictable events while at the same time continuing production. Team-1 also pointed out that it was rigorous practicing that allowed them to adapt to the unpredictable conditions of the market by being able to confidently take any profitable order from the order board in any card size (i.e. A5, A6 or A7) and successfully fulfil it.

6.3.1.5 Testing limits and challenging the assumptions

Finally, the resilient and high performing teams were observed to be willing to challenge assumptions and test their own and other limits. This decreased the possibility of facing adversities caused by overloading the team and the members with tasks beyond their ability to handle (such as taking an order too difficult for the production capacity of the team) and increased the performance by preventing the team from adopting an overly conservative approach (such as constantly taking orders far below the production capacity of the team).

All the teams are briefed about the simulation in the same manner, however, some rules are interpreted by different teams in different ways. With regards to conforming to the rules and attempting to meet the quality criteria, some teams tend to be very

conservative whereas others are too relaxed. The former type of teams may be so strict in applying the quality criteria that they are very slow in production process; they interpret the rules very literally and never consider ways to 'stretch' them. Conversely, the latter type of teams may be so careless about the quality criteria that their orders are repeatedly rejected by the controllers. Examples of both types of teams are abundant among the participating teams, particularly among the low and mid-level performing teams. For example, Team-50 finished with a loss of -£2,014 and was ranked 10th rank out of 15 teams in its game, despite having zero rejections from the controllers. Afterwards, reflecting the exercise, they reported that they felt they were too conservative and paid too much attention to quality, internally rejecting cards on the basis of very minor issues (an example internal rejection reason was: "That "a" on the bottom looks weird"). They admitted that they never challenged the early assumptions they had made with regards to quality, and only after the trading period they realised that cards with minor issues were acceptable. They regretted never thinking to question the controllers about what was acceptable.

In another example, Team-58, never thought to ask the controllers to borrow equipment for trial production and assumed that stencilling would be the easiest process of production. Since they had only created one stenciller role and ordered only one stencil, they could not then pursue high-end orders in the trading period because of their stencilling bottleneck. Similarly, they also did not question whether they could make and bring templates to the trading period and assumed that it was against the rules to do so. This was in fact allowed as long as permission was sought in advance (the guidelines actually state this possibility) and most teams used such templates – something which improved the speed and accuracy of production considerably. Without a template, Team-58 wasted tremendous time trying to centralize their verses and therefore was only able to pursue small orders. These problems coupled with the false interpretation of the quality criteria, again, something which they could have questioned prior to the trading period, and left them with a massive loss of -£2,841 at the end of the trading period.

On the other hand, with the successful teams, a pattern of questioning their own assumptions and the controllers was observed in relation to the rules and criteria. In general, most of these teams came to the strategic meetings with examples of the cards they had produced and asked the controllers about the acceptability and accuracy of their folding, centring, stencilling, writing, etc. Moreover, they asked about rhymes and

the acceptability of their verses and also of minor issues such as smudging or writing variations. These were all clear examples of testing limits and questioning constraints. Most of these teams also asked to borrow equipment and materials in order to make production trials with them. They also sought permission for materials they wanted to bring in to the trading period. On some occasions, these requests were rejected, however, the process demonstrated that these teams were trying to understand precisely the situation they were facing. For instance, Team-9 drew attention to the complexity and uncertainty of the briefing material, something which was indeed intentional in the design of the exercise. To address this, Team-9 did two things: first, they have discussed all the uncertainties in detail to establish a shared group understanding of them; and second, they reached out to the controllers to try and achieve greater clarity. For example, in the case handwriting variation, they asked the controllers about the strictness level and whether two people could write verses for the same order provided that their handwriting was not too different. Similarly, Team-2 emphasized how important "checking in with the controllers about the quality standards" was in determining their overall performance.

The ability to test the limits, to challenge the assumptions and to push the boundaries has also been identified by previous studies of resilience. Linnenluecke and Griffiths (2013, p. 407) argued that while dealing with emergencies, the exercise of thinking beyond 'current assumptions' might help organizations to better understand the adversity faced and broaden the choice of options for dealing with it. They suggest (Linnenluecke and Griffiths, 2013, p. 408) that organizations should 'push boundaries' to understand their 'limits' with regard to responding to disasters. Moreover, Seville *et al.* (2015, p. 10) proposed that organizations that "push boundaries, challenge conventional wisdom, and encourage innovative solutions" can establish *learning cultures*, which can, in turn, allow these organizations to adapt to the VUCA world more quickly. 'Questioning assumptions' is also one of the core principles of *collective mindfulness* (Weick, Sutcliffe and Obstfeld, 2000, p. 38). Lastly, Flin and Fruhen (2015, p. 87) mentioned the importance of "questioning old assumptions" in accurately interpreting the ambiguous information to provide for safety.

6.3.2 Effective information processing

6.3.2.1 Establishment of intra-team communication system

An important concept discussed in the previous literature as one of the antecedents of resilience is the establishment of an *effective communication system*, which opens the way for the *effective information processing*. Crisis management researchers argue that communication channels and information sharing mechanisms are among the first casualties of adversity (Quarantelli, 1988); and Weick (1993) proposed that this is among the most important reasons behind the collapse of collective mental models (i.e. transactive memory systems and collective mindfulness) when faced with adversity. Sutcliffe and Vogus (2003) support this proposition by pointing out as a response to an adversity, *broadening the information processing* enables the establishment of situational awareness and enhances understanding of the requirements of an effective response; thereby, increasing resilience. *Communication*, in the form of the flow of relevant information, is also suggested as one of the dimensions of resilience by Horne and Orr (1997) by enhancing the establishment and preservation of collective mental models. Similarly, Fioratou *et al.* (2010, p. 84) also proposed that preservation of situational awareness in a "distributed cognitive system" requires continuous interaction among its components. Moreover, communication has also been empirically tested and validated as an important source of resilience by Gomes *et al.* (2014), Furniss *et al.* (2011) and Jaaron and Backhouse (2014).

Although it is not included in the quantitative analysis, *effective communication and information processing* were also observed in the qualitative data. For example, one of the distinct qualities of Team-1, the best performing team among all 68 teams, was the attention they paid to *effective communication*. They prioritised e collective contribution to the decision-making process as well as rapid response to operational issues; and with that purpose, they established an online platform they named the "executive board communication channel (EBCC)". Through that platform, before and during the trading period, all information with regard to the operations of the team was gathered at a single point that was available to all the members. In addition, they also tried different communication structures while conducting trading period trials in the preparation phase and applied the most effective one in the actual trading period. They worked particularly hard to ensure that there were no misunderstandings between the order-taker and the production unit. Lastly, while reflecting on the simulation in the

aftermath, they identified their "active communication and openness" as a feature that made them a resilient and high-performing team.

Similar to Team-1, Team-9 established an Office365 work group to communicate and share information. This not only allowed them to overcome misunderstandings on matters such as when and where to meet (assisting in their achievement of 100% attendance at all meetings and practice sessions), but also equipped all team members with up-to-date information with regard to decisions taken and work carried out.

Conversely, problems with communication and information transfers prevented teams from effectively responding to challenges. For example, when order submitters were not able to effectively communicate controller feedback about rejections to the production units, the mistakes that were causing the rejections continued. This was an important issue for most of the low performing teams. There were even teams in which the production unit was not aware of the fact that most of their production was being rejected by the controllers. It was particularly a problem for Team-63 as they had seven orders rejected throughout the trading period on the grounds of inaccuracies with centralization, folding, rhymes and stencilling. However, the team's order submitters did not relay the controllers' feedback to their production unit effectively. A similar problem was revealed by Team-54 during their post-trading presentation. The source of their problem was the excessive work load of the operations manager of the team. According to the team, manager was overloaded with order taking, order submitting and overall monitoring and, in middle of all this work, s/he was ineffective in processing the rejection feedback to the production unit. Production unit members could not find a "point of contact" within the team to raise issues or to question the reasons behind the rejections. This was also an explicit indication of a communication problem.

6.3.2.2 Effective information gathering

Although it is extremely important to establish a communication system that enables effective movement of information within the team, it is also crucial to acquire the information from the surroundings in the first place. Previous literature identified the importance of establishing *situational awareness* in addressing and overcoming challenges (LaPorte, 1996; Sheffi and Rice Jr., 2005; Burnard and Bhamra, 2011). To establish *situational awareness*, studies proposed being attentive to weak signals about possible adversities (Weick, Sutcliffe and Obstfeld, 2008, p. 43), confirming the

credibility of information from multiple information sources (Mallak, 1998a, p. 151), and integrating the information gathered from multiple sources to establish a comprehensive picture of the operational environment (Fruhen *et al.*, 2014, p. 32; Alliger *et al.*, 2015, p. 180). The analysis of my exploratory study demonstrated the importance of establishing effective information gathering channels in realizing and understanding problems and formulating responses to address them.

The qualitative data also reveal the importance of utilizing information gathering channels to establish situational awareness and thereby realize challenges at an early stage, understanding them and formulating effective solutions. One of the most obvious indications of this in the trading period is the ability to monitor the order board and to quickly recognise when desired order(s) are displayed. Being able to quickly realize a desired order allows a team to obtain it and increase profits. Losing such an order to another team may cause motivational as well as performance-related deficiencies, as well as issues with inventory management if materials have already been purchased. A team unable to obtain a desired order may need to take another one that is incompatible with its initial strategy, production capacities or current inventory. Hence, high-performing teams typically track the order board continuously and rapidly secure the desired orders, which prevents possible difficulties.

On the other hand, it is also crucial to prevent the flow of unnecessary and potentially harmful information (Weick, Sutcliffe and Obstfeld, 2008, p. 44). Excessive information overloads communication channels and obstructs the processing of high-priority information. It may also reduce enthusiasm and the will to confront challenges, especially if the information demoralizing and not solution-oriented. For instance, when Team-36 production unit was working on their second order, the news of the rejection of their first order arrived in the middle of the operation. This disrupted their cohesion and paved way for the rejection of the second order, too. If the rejection news had been concealed and only feedback on possible improvements given, the second submission might have been accepted.

Having said that, teams should be very careful when deciding the necessity of a particular piece of information. For instance, production units unaware of the low-quality of their work have little reason to improve quality, mistakenly thinking that they are at an acceptable level. As a consequence, restricting information flow and not providing the necessary feedback prevents teams from addressing the challenges

quickly and efficiently. Yet revealing all information to all parties might also have negative consequences in the form of overloaded channels or decreased motivation (in the case of bad news).

6.4 Discovery of new relationships

This section presents the qualitative findings that were independent from and additional to the original research model. Although my quantitative analysis systematically tested a part of the relationships proposed in the research model, while I was examining the qualitative data, I discovered other team attributes and processes that appeared important in addressing and overcoming the challenges of the operational environment. Hence, I decided to investigate these relationships further. The results of this investigation are provided in the section below. Because these attributes were not theorized during my literature analysis, I decided not to include them in the final version of my model of resilience.

6.4.1 Managing Diversity

First of all, an ability to blend cultural strengths and to balance diversity was observed as an important resilience precursor. Diversity is proposed to facilitate the enrichment of a team's action repertoire; and hence, it is regarded as an important resource to support resilience (Sutcliffe and Vogus, 2003; Boin and McConnell, 2007; Gomes *et al.*, 2014); however, only so long as it is managed well.

When the members of a team were able to accept the possibility of diverse (and sometimes even contradicting) understandings among the members; and were tolerant and patient towards one another in spite of their differences, increased diversity became a strength in responding to challenges. For instance, Team-12 had members from different cultures which had the potential to impede team performance. There were members whose culture (culture-A) favoured direct communication and involvement in the conversation whenever an opportunity arose. On the other hand, there were also people who were much more indirect and only involved in the conversation when it was explicitly expected of them (culture-B). This might have caused overreliance of the ideas of culture-A members and undermining of the ideas of culture-B members. Culture-B members found it difficult to get the chance to express themselves while culture-A members concluded that culture B members had nothing to

say. This could also cause culture-A members to think that culture-B members were not enthusiastic enough, whereas culture-B people perceived culture-A members as wanting to decide everything. However, as a team they first paid attention to understanding the different expression styles of each members and then found a middle ground so that all could join to the decision-making process. Once possible negative effects of diversity were overcome, they realised that their diversity was one of their competitive advantages. For example, because of the specificities of the different cultures, some members were happier with roles requiring creativity whereas others were better at repetitive tasks. Moreover, some members were talented and enthusiastic about monitoring the overall organization, whereas others excelled at specialized roles. Consequentially, the team negotiated a map of who should do what when specific challenges arose. Team-12 stated this as one of the reasons behind their satisfactory performance.

Conversely, cultural differences and the misunderstandings originating from diversity sometimes paved the way to intra-team conflict, in which case diversity became a burden on the team. Most low performing teams identified **cultural differences** among the problems that impeded their performance. Team-58 stated how they experienced a "clash of cultures" with certain behaviours normal to a culture perceived as offensive by members from another culture. Moreover, the indirectness of certain members was perceived as a lack of enthusiasm. Similarly, in Team-59 passiveness of the certain members was perceived as "social loafing" behaviour, whereas it might be attributable to the specific behaviour styles of their culture. Lastly, Team-65 stated how the silence of certain members were misinterpreted as "acceptance" and this became a false group norm. This norm carried into the trading period as well: for instance, a member underestimated the time and effort required to complete open orders and suggested taking several open orders to keep them busy. This became the team's decision when no objections raised, and they were left with the burden of several unfinished open orders at the end. This demonstrates the importance of managing diversity, which could be in the form of explicit feedback or "voting" on crucial decisions in this example. Depending on the types of differences among the members, teams need to find ways to utilize them in addressing challenges as well as to manage them in prevent diversity from deteriorating cohesion.

6.4.2 Trust in other team members

As mentioned in the literature analysis chapter, *trust* is conceptualized as one of the precursors of resilience in a number of resilience studies. For instance, in the socioecological resilience field, Carpenter *et al.* (2012, p. 3253) referred *trust* as one of the conditions that enables resilience by decreasing levels of uncertainty and encouraging actors to focus on meeting challenges rather than other actors' behaviour which may be seen as irresponsible or incompetent. In the organizational resilience field, Weick *et al.* (2008, p. 46) argued that resilient responses to the challenges can be provided by established *trust* within the organization. Exemplifying this, the negative effects of the 1997 fire in Aisin Seiki's plant were quickly overcome with the help of the competitors; and this was only possible because the firm trusted its competitors' respect for its property rights (Nishiguchi and Beaudet, 1998, p. 57). Trusting them, Aisin Seiki allowed competitors into its premises to help with the recovery efforts. In the team resilience field, too, Morgan *et al.* (2013) and Bowers *et al.* (2017) proposed *trust* as one of the enablers of team resilience and Stephens *et al.* (2013, p. 29) validated this with quantitative empirical analysis.

In this study, I investigated *trust* quantitatively in the form of "trust in the expertise of other team members" as a part of the *transactive memory systems* construct, and found it to be positively and meaningfully correlated to *team resilience* (Pearson correlation coefficient=0.66, $p<0.001$ and $n=68$). This quantitative finding is further reinforced by the qualitative data. Almost all the successful teams explicitly mentioned the positive effect of *trust* on their resilience and performance, both in the form of "trust in expertise" and in the form of "trust in responsible behaviour". For example, Team-1 referred to *trust* as one of the key elements behind their successful performance and added that *trust* increased their willingness to share and accept information which, in turn, boosted their situational awareness and allowed them to quickly respond to adversity. In particular, the trust they placed on their decision-makers during the trading period allowed them to quickly agree responsive actions and unhesitatingly implement these.

Conversely, the teams who reported a *lack of trust* among team members linked this lack to slow information processing, decreased situational awareness, role conflicts and ineffective challenge-response processes. For instance, Team-63 accounted how a lack of trust in the expertise and responsibility of other members weakened the

organization of the team. For example, when a particular individual lacked trust in the officially appointed leader, s/he started to assume the leadership role. This created confusion amongst the other members as to which individual to follow. Unfortunately, this lack of trust was not limited to the appointed leader's expertise: some way into the trading period, the folder assumed order-taker tasks, the stenciller became the delivery person and the overall decision-maker was drawn into production. This extreme role ambiguity was a result of the inability of members to prove their expertise and responsibility to the other members.

At this point, an important question is: "How were the successful teams able establish such a culture of trust?" The experience of Team-2 suggests that such a culture was established prior to the trading period, with meetings where group norms were discussed in detail with active participation of all members and through practice sessions where each member could observe the work process of other members. Team-2 intensively invested in the preparation period with all members spending as much time as possible on both individual and group studies. On the one hand, in the meetings, each member revealed what they expected from the trading period and how they were approaching it. This made other members realise that everybody was willing to work hard to be successful, which was then demonstrated by full participation in every meeting. On the other hand, in the practise sessions, each member observed how the others successfully accomplished their tasks and they were credible in the information they provided. Hence, in the trading period, it was straightforward for Team-2 members to trust the information obtained from other members. Nobody felt it necessary to obsessively monitor others to check whether they were able to fulfil their duties.

In line with this, **misplaced** trust that is not based on a proven expertise and responsibility might lead to unfavourable outcomes. For instance, Team-68 trusted the financial knowledge of one of their members without establishing their degree of financial expertise, and did not question the financial model s/he developed. This model failed to accurately identify the most profitable orders or to provide a viable and cost-efficient plan.

Thus, while not establishing trust among members may lead to redundancy in the form of monitoring, suspicion and double-checking, establishing misplaced trust may limit useful scepticism and *conceptual slack* (Weick, Sutcliffe and Obstfeld, 2008, p. 43).

6.4.3 Supportive team members / team atmosphere

From the analysis of the qualitative data, another key element in achieving resilience and satisfactory performance was found to be supportive and positive team atmosphere. It is crucial as a source of motivation and enthusiasm and also for encourage members to openly report the mistakes and problems without the fear of being blamed; which is important in establishing "pre-occupation with failure", one of the principles *collective mindfulness* (Weick, Sutcliffe and Obstfeld, 2008). Moreover, it is also crucial during the preparation phase to enable every member to constructively question and challenge suggestions without fear of disapproval. If members feel that constructive criticism is not tolerated, then they will not express their ideas and opinions in meetings. The negative outcomes of this are twofold: members might start to feel demotivated and problems related to decisions taken might not be revealed.

Examples of this include "how such an environment motivated them and increased their productivity" (Team-3) or "how having a no-blame culture helped them beat the stress during the trading period" (Team-11). Team-7 and Team-4 particularly mentioned the importance of supportive atmosphere in encouraging the members to "give opinions", "come up with creative solutions", "contribute to the conversation" and "speak freely". Adding to these, Team-2 drew attention to the importance of motivational and positively informative quotes such as "You did a great job!", "It wasn't our rejection" (whenever the rejection whistle was blown) or "Keep going, you can do this" as a part of such supportive atmosphere in boosting productivity and in increasing the effectiveness of the challenge-response process.

On the other hand, the damage caused by an unsupportive environment was strongly emphasized by several low resilience and low performance teams as a source of demotivation, anxiety and unhappiness. For example, in Team-34 certain members dominated the decision-making process and did not provide a favourable environment for others to express opinions. Unspoken opinions were assumed to be positive and planning and organization decisions were made by a few members. On the trading day, it was revealed that these decisions were not happily embraced by all the members. When such an unfavourable team atmosphere resulted in problems such as rejected orders, no member had the courage to take crucial decisions as a "no-blame culture" had not developed. This resulted in the inability to respond to the problems and ultimately resulted in an unsatisfactory performance.

Similarly, Team-58 also reported how decisions were taken by only a few members; and in order not to risk the team cohesion other members conformed to these decisions, despite having doubts about them. What is observed from most of the low performance teams was the reluctance of some members to question or challenge decisions taken out of a fear of being the person that broke the team cohesion, just as in Team-58. Team-64, Team-54 and Team-41 all pointed this out. Even Team-16, which was among the most successful teams, stated that some decisions were not challenged in order not to break unanimity. This possibly arises from the fear of being isolated and also being responsible for the consequences of the proposition made. An obvious consequence of this reluctance is a lack of discussion with regard to the possible drawbacks of the decisions taken. Without knowing, discussing and anticipating these drawbacks, teams became vulnerable to the adversities caused by them and ineffective in addressing them.

6.5 Concluding remarks

This chapter introduces the qualitative findings of my research; and enrichens the understanding of the relationships among resilience, performance and their antecedents. According to my qualitative analysis of the anecdotes from the experiences of the participating teams, collected via direct observations as well as individual and collective reflections, knowledge accumulation in the form of strategizing, planning, specializing, training, practicing, testing and challenging broadens action repertoire and this, in turn, facilitates the effectiveness of challenge-response process. Moreover, establishing effective information processing structures is also crucial in addressing and overcoming that challenges. An effective intra-team communication system contributes to the establishment and continuous updating of the collective mental models; and effective information gathering (from the surrounding) enables the establishment of situational awareness. With situational awareness, teams are able to detect the early and weak signals of the challenges; and hence, address them before they turn into bigger problems.

In addition to the exploration of the relationships of the research model, with qualitative data, I also discovered other dynamics crucial in overcoming challenges. Firstly, I found diversity as an important source of resilience in formulating responses, particularly to novel challenges, however, diversity needs to be managed well in order

not to deteriorate team cohesion. Secondly, I found trust as an important factor in increasing the effectiveness of challenge-response, as it enables individuals to focus on accomplishing their tasks instead of double-checking others' work. Lastly, I found a supporting team atmosphere important in open discussion of mistakes, which contributes to the accuracy of collective mental models. In addition to this, a supportive team atmosphere was also seen crucial for the motivation and enthusiasm needed for members to maintain their performance levels until the end of the trading.

In the next chapter, I introduce the finalized version of my model of resilience, and then, I discuss what my investigations suggest in answering the research questions that guided my study. Further to this, I provide the academic and practical implications that may be derived from the results of my investigations. Finally, I lay out the limitations of my research and my recommendations for the researchers who desires to investigate resilience in the future.

7 Discussion

7.1 Introduction

This chapter is devoted to demonstrating how the findings of this study addressed my research questions and build on the previous literature. I also lay out the implications of my findings and the limitations of this research in this chapter. I first provide the final version of my model of team resilience, which was developed further in the light of the findings from my main study. Second, I restate my research questions and propose answers to them. Then, in two sections, I articulate the implications for the organizations and teams more generally. In the first of these two sections, I discuss academical implications, paying particular attention to how the results of this study may be used to develop theory in the fields of *organizational resilience* and *team performance* fields as well as other relevant topics such as *collective mental models, effective teamwork* and *team dynamics.* In the second section, I explore the practical implications of my findings for teams and organizations that operate in dynamic and turbulent environments and make some suggestions with regard to how they can ensure continuity, sustainability and endurance. Lastly, I discuss the conceptual and methodological limitations of my study and provide suggestions for how these may be overcome in the future. In this section, I also make recommendations for other researchers in the field of organizational and team resilience.

7.2 Model of Team Resilience

As a result of my analyses, I updated the conceptual model a further time. The final version is presented in Figure 16. Using the quantitative analysis described in chapter 5, I conducted hypothesis tests to test some of the relationships I proposed in the operationalized version of my model. Moreover, utilizing qualitative data, I examined the relationships tested with the quantitative analysis to understand how they were formed and manifested, and where possible, the underlying mechanisms at work. In addition to this, I also investigated those relationships that I could not test through the quantitative analysis in the light of the qualitative data. In some cases, the qualitative data also revealed attributes and relationships that I had not included in my conceptual model. As a result of this process, I amended the model and brought it into its final form. It should be noted that some of these amendments are derived mainly from the

qualitative data. Given the limitations of this, those relationships that are solely based on the qualitative investigations require further testing before one can be confident that they are indeed robust.

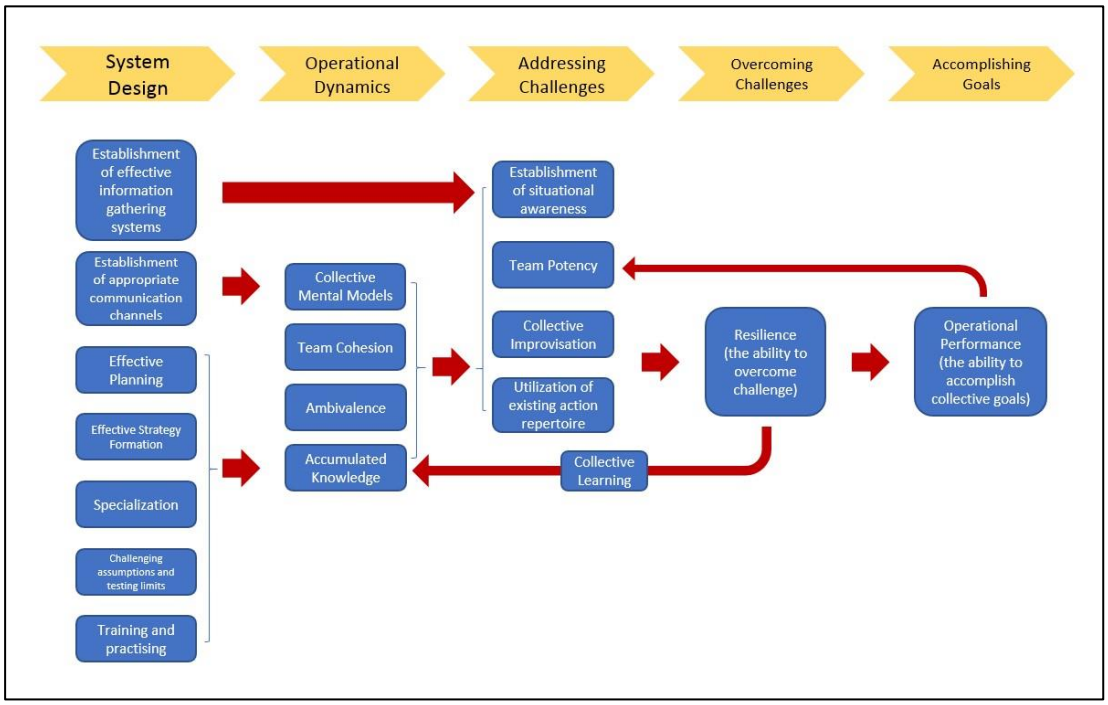

Figure 16. Model of Collective Resilience

The final version of the model suggests that resilience to challenging conditions in an operational environment is related to certain pre-operational and operational collective dynamics. Pre-operational dynamics are about preparing the system for challenging conditions when time and resource-related restrictions are much less acute than during trading itself. According to my analyses, these dynamics involved the development of effective communication and information gathering systems as well as activities that help in the accumulation of knowledge which broadens action repertoires. These system development actions facilitate the functioning of operational dynamics during trading, which allows the teams to effectively address and overcome challenges.

I identified the operational dynamics which appear to be effective in creating and maintaining resilience as collective mental models, team cohesion, ambivalence and accumulated knowledge. As demonstrated by both the quantitative and qualitative

analyses, establishing *collective mental models* helps team members informed of key operational dynamics and conditions. Through the information gathering and sharing activities of members, the collective picture of operational dynamics and conditions is constantly updated and the picture in each member's mind is synchronized to the updated collective picture. This, in turn, helps teams to establish situational awareness of operations and thereby detect early and/or weak signals of forthcoming challenges. To effectively respond to these challenges, teams should collectively act on these signals, which requires members to work *cohesively*. Moreover, in order to achieve effective responses, which require planning, deciding, formulating solutions and implementing these, action repertoires need to be sufficiently broad – hence the importance of knowledge accumulation. Finally, ambivalent attitudes towards existing knowledge and plans enable deviation from pre-planned responses modelled during pre-operational periods when this is required. This essentially means a capacity to improvise.

To effectively address and overcome challenges, it is therefore necessary to establish situational awareness of operations. Effective information gathering systems established prior to operations are part of this. If a team faces novel challenges for which its existing action repertoire is inadequate, then the ability to improvise becomes important in generating alternative solutions. These features ensure that challenges are detected in a timely, way understood thoroughly by team members, addressed accurately and responded to effectively, all which result in a resilient team. This resilience, in turn, contributes to satisfactory performance.

The relationship between resilience and team potency was non-significant according to the quantitative analysis; however, with the help of qualitative data, this result was explained as such: team potency only appeared to be beneficial when it was not groundless, i.e. when feelings of potency were accompanied by real team capabilities. Moreover, according to *some* of the quantitative analyses, the relationships between team resilience and collective improvisation and between team resilience and team cohesion were non-significant. However, in the light of qualitative data, collective improvisation and ambivalence appeared to be important when teams were subject to novel challenges, such as those requiring deviation from a plan and the rapid generation of alternative options. Moreover, in the face of challenges, cohesive teams appeared better able to coordinate actions and implement counter measures.

Finally, two feedback loops are included in the model. Firstly, addressing and overcoming challenges, particularly novel challenges, was observed to improve accumulated knowledge through collective learning and acquisition of the necessary skills. This, in turn, broadened a team's action repertoire, better equipping it for future challenges. Secondly, poor performance was likely to be serve as an additional source of adversity, lowering team potency and consequently increasing stress. Lowered potency, in turn, may cause the members to doubt the decisions and actions they are taking to overcome problems created by low performance, hence potentially decreasing the effectiveness of responses even further. Dealing with issues caused by low performance may also reduce situational awareness, detecting early signals of other potential challenges, formulating effective solutions and/or effectively implementing these solutions. Conversely, improved performance may positively affect the challenge-response process by enhancing potency, and hence, improving responses.

7.3 Research questions re-visited

The process by which I developed of my research questions was described in section 2.5. As detailed there, I came up with two main questions as a result of my literature analysis in the first year of my study: "What are the precursors of team resilience?" and "How is team resilience related to team performance?" In this section, I seek to provide answers to these questions in the light of the results of my studies.

7.3.1 What are the precursors of team resilience?

Earlier conceptual investigations of organizational resilience (e.g. Sutcliffe and Vogus, 2003), as well as more recent ones (e.g. Linnenluecke, 2017) pointed to "the identification of the collective capabilities and capacities that contribute to resilience" as one of the most important unresolved issues of the field. In this regard, resilience researchers have observed that there is a lack of generally accepted and widely applied framework to explain resilience along with its antecedents and outcomes (Annarelli and Nonino, 2016, p. 8; Kamalahmadi and Parast, 2016, p. 126; Linnenluecke, 2017, p. 16). Hence my first research question sought to address this issue by identifying these collective capabilities.

To answer this question, I first constructed a tentative framework based on the propositions and findings of previous studies, utilizing various research streams of the

resilience field. Then, I tested this framework with my exploratory and main studies. As a result of the quantitative and qualitative analyses conducted in these studies, I updated the framework to its final version as shown in Figure 16. As seen in this model, various collective dynamics are identified as the precursors of team resilience. Among them, *collective mental models* received the strongest empirical support from my analysis results. In the main study, using two previously developed scales, namely *collective mindfulness* (Weick and Sutcliffe, 2007) and *transactive memory systems* (Lewis, 2003), I quantitatively tested the relationships between team resilience and collective mental models. The results showed a strong and meaningful relationship. Moreover, both in the exploratory and main studies, qualitative anecdotes revealed the importance of collective mental models in addressing and overcoming challenges. Qualitative analysis also revealed that *effective communication systems* are necessary to establish and maintain *collective mental models* among the team members. Teams that had continuous and effective information sharing among its members were able to establish and update the common picture of operations and synchronize this with the picture in each member's mind.

Moreover, *team cohesion* was also tested both quantitatively, using the scale developed by Chang and Bordia (2001), and qualitatively throughout my study. Although this collective dynamic was not included in the initial model, it was revealed as an important capacity to effectively address problems in the exploratory study; hence, added in the model. Quantitative analysis partially supported its relationship with resilience, yielding a significant positive coefficient in the correlation analysis but a non-significant positive coefficient in the regression and path analyses. Nonetheless, qualitative anecdotes advised for the importance of coordinated and unified collective act towards achieving shared purposes and accomplishing collective goals rapidly and efficiently.

Finally, two dynamics in the model, namely *team potency* and *collective improvisation*, were also tested quantitatively in the main study. Team potency was included in the model after the analyses of the exploratory study, which demonstrated the importance of a team's belief in its abilities to overcome a problem. However, the quantitative analysis of its relationship with team resilience did not yield significant results. Examining the qualitative data, I concluded that there were both resilient and non-resilient potent teams and the difference between them appeared to be the breadth of their respective action repertoires. In other words, when a team was equipped with a

rich action repertoire, being potent contributed to resilience; when such a repertoire was absent, it did not.

Collective improvisation was included in the initial model. In the exploratory study, teams were not observed to improvise extensively, and I concluded that the strictly pre-determined design (pre-determined problems, solutions and clues) of the Escape Game exercise might not give scope for teams to generate several response alternatives. In the main study, quantitative analyses yielded mixed results: all indicated a positive relationship between improvisation and resilience, however some of these results were non-significant. However, the qualitative data strongly suggested that the ability to improvise, along with an ambivalent attitude towards previously modelled responses (which were included in the action repertoire), was particularly important when faced with novel challenges that could not be addressed using existing action repertoires.

Although included in the initial model, because of the methodological difficulties and the compromises I made during the selection of quantitative measures, certain precursors could not be tested quantitatively in my analyses. One of these precursors is *accumulated knowledge*, which also could not be tested in the exploratory study. The reason it could not be tested in the exploratory study was that "escape games" require participants to have as little information and practice as possible to preserve the novelty of the problems faced during the exercise. Hence, participants did not have prior knowledge of the situation they faced. However, my conversations with people who ran and played Escape Games indicated that prior experience of the exercise affects performance. The qualitative data from the main study also strongly suggested that knowledge accumulated prior to the trading day (in the form of planning, modelling, strategizing, specializing, practising, etc.) was effective in quickly detecting challenges and formulating effective responses. The teams that tried to anticipate and model the conditions of the trading period became familiar with the possible challenges and they broadened their action repertoire by formulating response alternatives. This in turn allowed them to address and overcome the challenges rapidly and effectively.

For similar reasons, *effective communication* and *information gathering systems* also could not be measured quantitatively; however, qualitative data particularly advised for the importance of these systems in establishing *situational awareness*, which allows teams to detect the early and weak signals of challenges (Weick, Sutcliffe and Obstfeld,

2008, pp. 43–44). Qualitative anecdotes demonstrated that teams that had effective communication among its members were able to establish and constantly update their collective mental models with regard to the operational dynamics and environment. Effective information gathering systems were also important in updating the overall shared picture of operations and this in turn provided teams with the capacity to detect early and weak signals of forthcoming challenges.

7.3.2 Is team resilience related to team performance and if so, how?

In addition to identifying the dynamics that contribute to resilience, understanding the outcomes of resilience was also an extremely important objective in my study. As I elaborated in the introduction and literature analysis chapters, most of the previous resilience research has focused on extreme organizational settings (for the detailed discussion refer to sections 1.1 and 2.3). In these settings, resilience is important to provide "safe and reliable performance" (Sutcliffe, Paine and Pronovost, 2016, p. 1) as well as survival of the team or organization in question (Linnenluecke, Griffiths and Winn, 2012, p. 17). However, the majority of organizations and teams operate in non-extreme settings where safety and survival is not necessarily such an immediate concern. The much more immediate and pressing concern for many units is to achieve and maintain satisfactory performance levels in the face of a constant stream of challenges, many of them relatively minor but still potentially disruptive (Sheffi and Rice Jr., 2005; Ponomarov and Holcomb, 2009; Burnard and Bhamra, 2011).

I, therefore, sought to derive objective measures of team *performance* to analyse the relationship between resilience and performance. In my exploratory study, I operationalized performance using the time taken by teams to solve the puzzles and unlock themselves from the room. Although this operationalization provided an objective measurement of performance, it did not allow me to differentiate between the ability to overcome challenges and the ability to accomplish collective operational goals. Such differentiation could not be achieved in my exploratory study as participating teams did not have any collective operational goal; or any goal other than solving the puzzles and unlocking themselves from the room. In contrast, real life teams (and other collective entities) are formed to accomplish certain goals and they have operations to accomplish these goals. While operating to accomplish these goals, they need to address and overcome the challenges they face and this is how they achieve resilience. Considering this, I decided that in the research setting I will use to collect

data, teams should have operational goals that are different from solving problems and overcoming challenges. Therefore, as a result of my exploratory study analysis, I re-conceptualized the outcome of resilience in my model as *operational performance* to indicate the level of accomplishing collective operational goals.

In my main study, the teams were required to profitably produce greetings cards in accordance with the prespecified criteria. Therefore, *operational performance* was measured using objective performance indicators such as *profit/loss*, *value of sales*, *number of cards produced*, and *rejection rate*. In the quantitative analyses, the relationships between team resilience (using Stephens *et al.*(2013)'s *team resilience* scale) and these objective performance data were tested using various analyses; and all analyses showed significant, positive relationship. To understand the mechanisms underlying this relationship, I utilized qualitative data. Qualitative data revealed that when teams were effective in addressing and overcoming the challenges of the operational environment (such as high volume of noise, low lightning conditions, inability to secure desired orders, inventory problems, intra-team conflicts, etc.), the quality and the volume of their production increased, which was reflected in operational performance indicators. On the contrary, when they are not able to absorb, respond to and therefore overcome challenges, their operational performance decreased.

Qualitative data suggest a cyclical, feedback relationship between resilience and performance, where the accomplishment of operational performance affects resilience as well as vice versa. Particularly when teams' products did not meet the strict quality criteria and orders were rejected by the controllers, teams' stress levels increased and their collective belief in their abilities (i.e. *team potency*) diminished. In turn, this appeared to decreased team effectiveness in detecting, addressing and overcoming challenges. This mechanism resembles to what *tightly coupled* systems experience, where because of limited time and slack, small problems may quickly escalate into bigger challenges (Roberts, 1990, p. 163). Similarly, for the teams in simulation, the inability to detect and overcome challenges deteriorates processes that provide quality, increase the level of rejection and rejection becomes a further source of challenge. Conversely, when teams were able to produce by meeting the quality criteria and delivery deadlines, their performance levels increased, their potency levels increased, and when combined with rich action repertoire, this contributed to their resilience to the forthcoming challenges.

7.4 Implications

In this section, I seek to articulate what the results of my study may mean for the academy as well as the practitioner world, and how these parties may apply these findings. The general implications of the findings are discussed in two parts. In the first part, theoretical as well as methodological implications are provided for academic communities interested in resilience. These implications may be relevant for sensemaking, high-reliability organizing and positive organizational scholarship communities. Moreover, resilience is investigated within the context of maintaining and boosting team performance; hence, this study may also be relevant for the academic communities working on team performance and teams that operate in challenging environments. In the second part, practical implications, aimed more at the practitioner audience, are discussed.

7.4.1 Academic implications

In this section, I discuss how the findings from my study may be utilized by the other scholars. I focus on three areas. First of all, I discuss the contribution of the model of team resilience developed in this study, which integrates insights from a number of different resilience research streams (namely, high-reliability organizing, sensemaking, positive organizational scholarship and crisis management). Second, I elaborate on the importance of treating resilience as a mediating construct and I suggest that resilience per se need not be the ultimate outcome that an entity aims to attain, but is rather a stepping stone on the way to other desirable states, such as satisfactory performance. Third, I indicate how, as opposed to the post-hoc investigations widely preferred in the field, this study adopted a different methodology and that allowed for real-time data collection and a closer investigation of the processes associated with appropriate responses to challenges that resulted in resilience. These characteristics are elaborated below with regards to how they may be useful for the further development of research.

7.4.1.1 A comprehensive framework to explain resilience

As argued by previous work (Annarelli and Nonino, 2016, p. 8; Kamalahmadi and Parast, 2016, p. 126; Linnenluecke, 2017, p. 16) and mentioned in this study, there is a lack of a generally accepted framework to explain resilience. As I described in the literature review chapter, there are several propositions for frameworks to explain resilience, produced by various researchers (Horne and Orr, 1997; e.g. Mallak, 1998a;

Lengnick-Hall and Beck, 2005; Stephenson, 2010b), however, none of them has been widely adopted so far. Addressing this gap, I developed and tested an integrative model of resilience. This model has the potential to be a generally accepted and widely applied framework for resilience for two important reasons.

Firstly, I developed it by integrating findings from different research streams of resilience. In the initial creation of this framework, I utilized several theoretical as well as empirical pieces of work and I investigated resilience from various perspectives, in various contexts and at various levels. This work includes organization studies (from research streams such as high-reliability organizing, positive organizational scholarship, and sensemaking) as well as engineering, ecology, sociology, psychology, systems. There are studies that look into one to one relationships between resilience and its proposed precursors as well as those that investigate several precursors simultaneously; there are quantitative investigations as well as qualitative and mixed investigations; there are conceptual developments as well as empirical examinations; and there are team level analyses as well as organizational, community, system and individual level analyses. The framework I established as a result of my investigation of these studies included their commonalities, addressed their contradictions and considered their idiosyncrasies. The model that I propose at the end of my research speaks to various streams of the resilience field and to various organizational contexts where resilience is required. This framework may be used by resilience researchers in various streams as a guide to investigate how challenges in various challenging organizational contexts may be addressed and overcome.

My qualitative investigation added an exploratory element to the analysis and also suggests the importance of other collective dynamics that have not yet been rigorously investigated by previous research. For instance, the qualitative findings demonstrated the effects of soft skills such as potency, trust or supportive team atmosphere on reporting mistakes and hence addressing and overcoming them more rapidly and effectively. Although I did not incorporate these attributes into the final version of my model because I was not able to rigorously test them, these findings could be fruitful research avenues for further investigation.

Secondly, the results of this research demonstrate that the capacities that were found to foster resilience in high-risk, safety critical settings where even the smallest mistakes are not tolerated may also be effective in supporting challenge-response

processes in less extreme conditions. A majority of the research conducted into resilience has drawn its results from the analysis of entities that are in either high-risk industries or that have been through extreme adversities such as terrorist attacks, nuclear explosions, natural disasters, etc (a detailed analysis of this work was presented in section 2.3). Therefore, the literature review, upon which the initial development of the research framework is based, is mainly comprised of such work on extreme cases. Although it is important to understand the dynamics of effectively responding to such extreme events, the direct applicability of this understanding is very limited as the probability of these extreme events is very low (Vogus and Welbourne, 2003). Therefore, it is important to test whether the capabilities found to foster resilience in extreme settings are also effective in less extreme settings.

In that sense, I have tested my framework by replicating non-extreme challenging conditions, which are more frequent in organizational settings but which threaten operational performance rather than reliability, continuity and safety. Although maintaining reliability, continuity and safety is a more important issue, for wider populations of organizations and teams, operational performance levels are more likely to be threatened by challenging conditions. Hence, by proposing a model of resilience to maintain and boost performance levels, my framework could be applied in a wider population of organizations compared to earlier models of resilience.

7.4.1.2 "Resilience" as an intermediary construct in the path

In the previous conceptualizations and empirical investigations of resilience, resilience was generally considered as an outcome variable (notable exceptions to this are detailed in section 2.5.2). Nevertheless, in more recent definitions, resilience is regarded as an ability that helps an entity to obtain a desired outcome (e.g. preserving identity or maintaining operational capacity). Therefore, in this study, in line with the adopted conceptualization of it, resilience is considered as an intermediary construct affecting *performance*, and being preceded by a set of precursors. This model has two significant implications.

On the one hand, the model stresses that resilience is a dynamic capacity, which can change, develop and improve; as opposed to the idea of resilience being a static capacity, which is either possessed or not (e.g. Meyer, 1982; Wildavsky, 1988). This study implies that by investing into certain capacities and capabilities, such as *collective mental models, team cohesion, effective communication and information gathering*

systems and *improvisation ability*, teams may improve their resilience to challenges and adversity. In addition, after enduring a challenge, capacities may be learned and developed, making the team more resilient in the face of the next challenge. The examination of the processes by which resilience develops (or not) over repeated challenge-response cycles may be a fruitful avenue to pursue.

On the other hand, this study adds to the conceptualization of resilience as the ultimate purpose of an entity (Lengnick-Hall and Beck, 2005; e.g. McDaniels *et al.*, 2008; Stephenson, 2010a), even when going through challenges. In line with the definition of resilience adopted in this study, being resilient to challenges and overcoming them is only meaningful if this allows an entity to achieve its greater purpose. In this study, I investigated resilience to the challenges of daily operational conditions; hence, that greater purpose has been maintaining and improving operational performance. Therefore, effectively dealing with challenges is essential so long as it leads to satisfactory performance levels. Adopting this logic, resilience researchers, or any researcher studying organizations in challenging environments, may treat resilience as a precursor construct of the ultimate goals pursued by the entity. This logic takes resilience research beyond studies that treat resilience as the ultimate outcome and tries to answer the question of "why providing for (or investing in providing for) resilience is necessary and beneficial".

7.4.1.3 Real-time methodologies

As mentioned in the literature review chapter, the academic resilience community does not yet appear to agree on a unanimous definition, conceptualization and operationalization of *resilience* (Linnenluecke, 2017, p. 15), suggesting that further work needs to be done in order to fully understand how resilience is manifested (van der Vegt *et al.*, 2015). This suggests that resilience researchers should conduct in-depth investigations to be able to grasp the root causes of being (or not being) able to demonstrate resilience. Of course, such thorough and profound investigation requires continuous observations, numerous interviews with various people involved and extensive secondary information. These requirements entail methodological problems. To begin with, it might be impractical, if not impossible, to wait to come across challenge-response processes while making observations. In addition, being observed while addressing challenges might disturb participants. Thus, it is extremely hard to do real-time data collections while investigating real-life resilience manifestations. Moreover, even for the post-hoc investigations, in certain instances, participants might

be reluctant to spend time on the data collection process or they might not want to reveal data they think might hurt their reputation. Even if the investigated party is collaborative and helpful, it might be a long process to understand where to look for useful information.

Because of these issues, empirical studies of resilience are mostly in the form of post-hoc investigations of entities that have been through different kinds of crises and data sources mostly rely on self-reports. This might be one of the reasons behind the lack of unanimity on definitions, conceptualizations and operationalisations of resilience. This implies that the field requires novel methodologies to progress. Addressing this, one of the novelties of my study is the use of a simulation methodology to generate data to test the proposed framework. This methodology lies somewhere in between experimental designs and field investigations. It does create an *artificial setting* in which to observe responses to challenges and adversities; however, no manipulations were used in order to try to ensure that challenges and responses were as authentic as and as naturally developed as possible. When observing the challenge-response processes of participating teams, it interesting to see processes very similar to those seen in investigations such as Weick's (1993) study on Mann Gulch disaster and Nishiguchi and Beaudet's (1998) study on Aisin Fire. However, the simulations were also effective in revealing, at least partially, how these processes came into being, how they manifested themselves and how they were developed and exercised. Hence, methodologies similar to the one used in my study could be developed and applied for other researching on *resilience* or other concepts that have the same multifaceted structure. Although the simulation method used in this study was based on a card manufacturing process, the same procedures could be applied to imitate different kinds of organizational environments and to replicate different operational processes. Examples could be top management decision-making processes, new product development processes or supply-chain product movement processes.

7.4.2 Practical implications

While designing this study, one of my main objectives was to test and validate the wider applicability of resilience principles, which were found to work for the teams and organizations operating in extreme conditions. As Alliger *et al.* pointed out (2015, p. 176):

> *"…resilience can be important for almost any business team, even when physical safety is not an issue. Challenges can diminish the ability to accomplish goals and tax the cohesion of virtually any team; so almost any team can benefit from greater resilience."*

The results suggest that even among the teams in this study, there were discriminations to be made in terms of which capacities to develop and how to develop these capacities. In this section I discuss the practical implications in three parts. In the first part, the advantages and disadvantages of permanent and temporary teams are discussed; and specific suggestions are made as to how to be resilient to challenges. In the second part, the focus turns to *challenges*, and the differences between responses to novel and non-novel challenges are elaborated. Finally, in the third part, work periods are examined; actions are proposed for operational as well as non-operational periods.

7.4.2.1 Permanent vs. temporary teams

Some teams work on continuous tasks and operate for long lasting periods, whereas some others are formed to accomplish specific projects that last for a short, limited period. Although at the formation stage of these teams all might have similar experiences, the former type strategizes and plans with a long-term perspective and, over time, and by facing the similar challenges, it accumulates much more knowledge. Therefore, for these former types of teams, response processes might have already become embedded in the routines, whereas temporary teams have to develop response processes as they encounter new challenges.

The importance of accumulated knowledge was demonstrated in my study, even though the teams involved were temporary teams. The participating teams met and formed only four weeks prior to the trading period and they were formed only to participate in the simulation and then dissolved afterwards. Nonetheless, the choice of how to utilize the four weeks was solely decided by them, so there were differences in terms of how much high-quality time they spent together (i.e. how many times they met, how long the meetings were and how they choose to spend this time). Some teams met more than once a week and some only met a few times and practice occurred in subunits and even individually. Some teams mingled, talked, specialized, strategized, planned, modelled and rigorously practiced in these meetings and in doing this replicated some of the challenges they would face in the trading period. This allowed

them both to develop responses to these possible challenges and to embed these responses into their planned routines, at least to a level.

Conversely, other teams did not consider alternative scenarios or did not encounter them prior to trading because of not practicing enough; in these cases, resilience can only come from improvised actions. However, as the qualitative data effectively illustrate, first, the turbulence and dynamism of challenging conditions inhibits the development of improvised actions; and second, even the improvised actions were best developed when previously established (or accumulated) action repertoire is rich. The implication of this is that, even for temporary teams, time spent to accumulate knowledge is extremely valuable.

This implies that for teams with no defined dissolution date, continuous investment in developing and improving routines will be even more rewarding. Such teams may discuss the regular challenges they face in order to create and embed the responses to these into their routines and also to talk about the irregular challenges faced and develop alternative action scenarios to address these. This would help them to establish *collective mental models* during challenging operational conditions. In addition, the planning and the organization embedded in the accomplishment of the routinized tasks may also be evaluated and, if necessary, amended in these meetings. For instance, if a specific form of specialization does not work, alternatives could be developed and even tried for a limited time. Finally, the results show the value of paying attention to the building *team cohesion* as its effect on resilience can be seen both quantitatively and qualitatively.

On the other hand, temporary teams may place greater attention on the generation of alternative scenarios and corresponding actions sets rather than trying to develop routines which they may never need. Working on the responses to different challenge scenarios will enrich their action repertoire, and they may be able to improvise more effectively in the face of irregular (or unexpected) challenges, which is possibly the type of challenge they will encounter the most. Moreover, as they might not have a second chance to reorganize themselves, temporary teams could focus on developing enhanced role flexibility and greater role knowledge to be able to fill in for another role if required. Hence, they might invest in developing collective mental models to have a shared and synchronized picture of the operations and roles. They could also benefit

from being more ambivalent towards plans and being ready to be flexibly deviate and improvise new actions when unexpected circumstances arise.

7.4.2.2 Novel vs. non-novel challenges

Particularly in the qualitative data, a distinction was observed between responses to novel (unexpected) and non-novel (expected) challenges. In the context of my study, non-novel challenges are the challenges either anticipated or considered during alternative scenario analyses or challenges encountered while practising the operational tasks and conducting trials of the trading period. In real-life, especially for permanent teams, non-novel challenges may also be challenges encountered regularly in the regular course of operations. These could be a stressful work atmosphere, tight deadlines, difficulties of tasks, risks of making mistakes, penalties for not accomplishing the tasks as the way they should be accomplished, and so on and so forth. Novel challenges are those that cannot easily be anticipated during scenario analyses and ones that have never been encountered before; they could be named as *irregular* challenges in the case of permanent teams.

Obviously, non-novel challenges are easier and less stressful to respond to because they have already been either experienced or considered. Particularly in terms of anticipation and consideration, the development of collective mental models is prominent. For example, if the members openly report and discuss previous mistakes and errors, the team can work on generating an effective solution before facing the same situation again. If overcoming a challenge requires collective effort, then it becomes important that the members know how to best communicate among each other and where to obtain the necessary information. All these will improve resilience, and in turn, lead to better performance. Such a sequence illustrates, once again, the importance of working on alternative plans, generating Plan-Bs, Cs, and Ds, as well as the importance of modelling operations, practicing individual tasks and making realistic trials of operations.

The feedback loop from resilience to accumulated knowledge is also important in the context of addressing non-novel challenges. When an entity overcomes a challenge, there is potential (derived from the experience) to develop the necessary skills and capacities to overcome that challenge. This potential may be utilized by collective learning activities (such as talking about the experience or recording the steps of overcoming the challenge) and thereby causing the response process of to become part

of its accumulated knowledge. This, in turn, can broaden entity's existing action repertoire and allow it to overcome similar challenges more quickly and efficiently.

Unfortunately, certain teams are operating in turbulent, dynamic, fast-paced environments such as technology-driven industries, where processes and routines may be altered on a daily basis. For these teams, alternative scenarios and extensive trials might not be effective in designing resilient responses to all challenges, as some challenges will be unexpected and some will have novel elements. For these challenges, the only preparation that can be (and possibly should be) done is to develop an understanding of "the *possibility* of unanticipated challenges" and to enrichen the *action repertoire* of members as much as possible in order to encourage the generation of *improvised* solutions right in the moment. Although improvisation is an *emergent capacity* that facilitates resilience, its achievability is strongly dependent on collective support for improvisation and also on the breadth of the previously developed action capacity.

Another important point is how information processing is exercised during operations, before and during an encounter with a novel challenge. Above all, the team has to detect the early signals of a novel challenge to have enough time to improvise a solution. This requires an effective *communication system* among the team members in order for every member to have a *cognitive map* of the operations and the surroundings, so that the right member can bring *signals* together at the right moment to recognize the arrival of a challenge. While processing relevant information, team should also be wary of overloading communication channels with unnecessary information. Thus, an effective information processing system should be capable of filtering *noise* as well as digesting the necessary data. Even after a novel challenge has been detected, the information processing system should still be intact for the collective generation and implementation of solutions. In the simulation, the best performing and most resilient teams were the ones that established communication structures that were not disrupted throughout the trading period. Therefore, particularly for resilience in the face of novel challenges, an effective information processing system is crucial, since detecting problems in the earliest instance and improvising and implementing novel responses requires an all-round and collective understanding of the circumstances.

7.4.2.3 Challenging (operational) vs. non-challenging (non-operational) periods

Finally, teams that have non-operational periods may take different sets of actions in operational and non-operational periods. The teams in the simulation had four weeks of non-operational time before trading took place; hence, they had this time to prepare to perform well in the turbulent and fast-faced market replication. The data clearly show that performance differences originated from different actions taken during the trading period as well as during the preparation period. First of all, it was evident that the capacity to respond resiliently had been developed prior to entering the trading period. For example, as elaborated in section 6.3.1.3, teams utilized effective specialization in the form of clearly defined roles allocated according to tested strengths and also in the form of a broad role knowledge coupled with appropriate flexibility to be able to fill in for other roles when necessary. This capacity was utilized (by certain teams) during operations, however, this capacity had been developed in the preparation period by defining roles, testing strengths, allocating roles, planning flexibilities, training on the main roles and then cross-training in other roles, and finally by practising extensively. In addition to building such capacities, modelling alternative scenarios, testing capabilities and limits, and challenging assumptions is easier to accomplish during these non-operational periods; and these are the most effective preparation actions to anticipate challenges, to respond to challenges and where possible to avoid these challenges in the first place.

However, even more crucial than these, fundamental strategies are often formulated in these non-operational periods. The non-operational periods are opportunities for a team to understand its functional and social dynamics. Hence, teams that operate in challenging operational conditions may need such non-operational periods for reflection and processing in order to be resilient during the operational (challenging) periods, where time and task pressure does not allow for such reflection and processing.

Non-operational periods are much less prone to disruption with fewer time constraints, no external disturbances and no penalties for errors. Therefore, if the members are left to behave more independently, supported to participate in the discussions, and encouraged to provide their ideas, opinions, comments and feedback; then more information will be available to the team to make the best strategic decisions. Organizational atmospheres where all-channel communication is encouraged might be the most appropriate choice for this, with decision alternatives proposed by everybody

and decisions taken by mutual agreement. Such an atmosphere would allow the assumptions behind proposals to be challenged by several minds, which should make the decisions more robust. Moreover, members can more easily disclose if they are not happy with a decision, and this would reduce the possibility of low member satisfaction and subsequent error proneness and performance reduction.

Contrarily, when a team is in challenging conditions, decisions have to be made quickly, and the team has to avoid ambiguity, conflict and hesitation. All these lengthen the response process which is likely to reduce resilience. Thus, in challenging periods, a centralized approach could be preferred to speed up the decision-making process. Even if an all-channel communication structure is preferred during the non-operational periods and a leader has not emerged naturally, a manager (or a decision-making committee) may be appointed to assume the decision-making power and responsibility when dealing with challenges.

7.5 Limitations and recommendations

7.5.1 Limitations

As with any research, there are certain limitations of what I have described here, which I shall explore in the section that follows.

Firstly, the data analysed in this study were collected using a simulation methodology, which means the results are based on an artificial setting rather than a real setting. As pointed out by Muijs (2013) the problem of conducting a research in an artificial setting is that these settings may not represent the complexity of real settings. Particularly in the case of experimental designs, controlling other possible effects to observe cause and effect relationships is unrealistic as in real life there might be multiple factors at work which might intermingle together in various ways. The simulation method I utilized in my study is not a pure experimental design as there was no systematic controlling or manipulation. The market replication was designed to be as realistic and natural as possible for the applicability of the results to real-life teams. During the implementation, the researchers did not intervene with the conditions the teams were going through.

Nevertheless, it is impossible to precisely reproduce the complexity of real life conditions in a simulation. It is highly likely that there are certain other factors

affecting the resilience of the teams that could not be observed because of the way the simulation was designed. Moreover, the negative outcomes of the challenges and adversities faced by teams may be more severe in real life, which in turn affect responses. Furthermore, the design of the simulation ensures that rational, strategic and operational behaviour tends to result in high performance and desired outcomes, which might not be the case in political, contested environments, for example. In the simulation, there is little in the way of politics and subterfuge. Controller decisions are as standardized as possible to provide for equality and 'a level playing field'; except for maybe a little room at the margins for exceptional inter-personal skills. On the contrary, in real-life consortiums are formed, bilateral agreements are signed, bribes are sometimes given, and power is exploited; so, there are various legal as well as illegal ways to secure outcomes other than just been good at what you do. Hence, in real life, overall performance may be an outcome of various other precursors in addition to the operational outcomes, which is not the case in simulation utilized in my study.

Lastly, the simulations replicate a market with challenging conditions in a non-extreme organizational setting. Different fast-paced and dynamic markets in different sectors and industries might have different types of challenges and adversities; and hence, there is the possibility of different precursors to be effective in permitting resilient responses to these challenges. For example, Holweg and Oliver (2015) investigated high-impact failures and near-misses in auto industry, and their analysis concluded that stakeholder relations, operations and management systems, market reach and scale are the sources of resilience in the auto industry (2015, p. 114). Particularly for high impact, one-off adversities (generally in the form of a large-scale crisis) and for larger organizations with more complex systems and dynamics, other dynamics (such as scale, financial reserves or relations with stakeholders, etc.) might play more crucial roles. Having said that, I established my framework by utilizing the resilience studies conducted in various sectors; therefore, the results are expected to be applicable in various different settings.

Secondly, as mentioned, resilience is a very complex phenomenon that is not be fully understood yet; and hence, investigating it and generalizing the results of this investigation requires a mix of quantitative and qualitative methods, where not only the manifestation of relationships can be closely examined, but also the relative importance of these relationships can be determined. Although I designed my study in such a way to permit me to observe, record and analyse team processes that lead to

resilience and, in turn, satisfactory performance; this study also demonstrated how hard it is to perfectly capture the manifestation of resilience, its antecedents and its outcomes. I concluded that manifestation of resilience in challenge-response processes is too *subtle* to be easily observed and recorded; and this study could only go so far to record and analyse its most imminent outcomes in the form of problems solved, challenges overcome, performance maintained and so on. All these indications of resilience, together with self-reported team resilience, are treated as the *proxies* of team resilience to understand its dynamics. However, the recordability of actual manifestation of resilience still remains as an important issue of the field.

One may claim that how data is captured is also relevant in the context of this limitation. Although the problem associated with self-report data is addressed with objective performance measures and observational data collection tools (non-systematic participant observations and audio and video recordings), data related to certain team dynamics and soft-skills were measured using self-report scales. As mentioned by various scholars, the operationalization of certain cognitive and behavioural processes that provide for resilience in challenging conditions, along with the concept of resilience itself, is a major challenge (Lewis *et al.*, 2011; Linnenluecke and Griffiths, 2011; Rose, 2004). Thus, self-report measures are utilized as the most convenient method of systematic data collection; and these measures are supported by a non-systematic observational data collection to (at least partially) overcome the limitations associated with self-report data, but they do have weaknesses.

Thirdly, considering the quantitative analysis methodologies utilized in this study, the sample size could be considered as a limitation. Certain scholars suggest using no less than 200 cases to obtain robust results with *path analysis* (Barrett, 2007; Foster, Barkus and Yavorsky, 2011b); and, of course, considering the number of predictors in the quantitative analyses, one may suggest a bigger sample would increase the power of generalizability (Maxwell, 2000). However, it should be noted that the relationships analysed in this study are based on the previous theorizations; hence, the results test and validate rather than provide novel assertions. Moreover, the relationships validated (or not) through quantitative analysis were not merely interpreted based on these results; the manifestations of these relationships were explained and illustrated utilizing qualitative data. In addition, this study is part of an ongoing project, so, the sample size will increase over time.

Fourthly, the way qualitative data was collected and utilized in this research is also a limitation. It was not feasible to directly observe teams during their four weeks of preparation. Moreover, because of the administrative work that needs to be done by the researcher-controllers during the trading period, no systematic real-time observations of trading period could be conducted. The information with regard to these periods was therefore mainly based on the collective and individual reflections of every team and its members, and supported by non-systematic observational and video data. Moreover, at the outset I did not intend to carry out a systematic analysis using qualitative data and only benefited from it as an extra source to support and complement the quantitative analysis in testing and validating the conceptual model. Therefore, particularly the parts of the finalized model (Figure 16) that were mainly investigated through qualitative data require further rigorous investigation for validation.

A final limitation particularly relates to applying the results of this study to permanent teams with an abundance of accumulated knowledge embedded into team routines and collective mental models. As described in the methodology chapter, the participating teams of the simulation were formed only four weeks prior to the trading period, which may be considered as a short period of time to develop routines to deal with challenges. Moreover, the duration of the trading period is limited (135 minutes) to allow participating teams to develop skills to be more resilient over time; and they only undertook the simulation once, which means that the effect of prior experience may only be observed through practicing and trials they report. Thus, the learning effect might not have been captured as well as desired. If teams were entered into the simulation a second time, they might better respond to the challenges and improve their performance (which is what almost all of them claim in the post-trading presentations). Therefore, one may conclude that the results of the simulation is not entirely applicable to permanent teams. This issue is acknowledged in the suggestions for permanent teams (section 7.4.2.1) along with the possible differences between temporary and permanent teams. To address this issue, in the parent project, we hope to include permanent teams and the results will be contrasted to detect any difference.

7.5.2 Recommendations for future studies into resilience

The investigation of the *resilience* concept is an ongoing and continuously improving process carried out by the ever-growing community of resilience scholars; and as

stated before, the work done for this study will also continue after the finish of the study. Consequently, there are several paths that could be followed to continue this work and also to progress resilience research in the organizational context. This section outlines some of these various paths and details the research that could be conducted.

7.5.2.1 Further exploration and validation of the framework

The most straightforward continuation of this research would be the testing and validation of the framework developed in this study by replicating it in various different research settings. I plan its first replication to be conducted on real-life teams as a field investigation, which would serve as an ecological validation to this study. This could be done in different studies choosing samples from different sectors or other sample specifications may be done with regards to the characteristics of the teams, the nature of the challenges and even the location (country, culture, environmental conditions, etc.) the teams operate in.

Moreover, validation may be made using different methodologies and different data collection tools. It may be a solely quantitative study by updating the questionnaires with the insight gained from qualitative finding of this study; or it may be a further qualitative analysis to try to discover ways to see the manifestation of resilience in action, along with observing its interaction with other concepts. For analyses involving quantitative methods, I may try to collect data from bigger samples to test the robustness of the results. The tools to collect qualitative or quantitative data may be updated to gain knowledge in varying angles. For example, observations could be made more rigorously and systematically by assigning an observer for each team or putting audio and video recording equipment on each table or interviews could be conducted after the simulation to obtain elaborated data on significant incidents.

7.5.2.2 The importance of paradoxes for the resilience research

While juxtaposing the qualitative findings with the previous literature, I identified a promising avenue as the relationship between resilience and *experienced paradoxes*. According to the findings of this study, it is revealed that teams that were successful at managing certain paradoxes were better able to demonstrate resilience. For example, some teams had both specialized members with clearly identified roles and the capacity to fill in a role that could not be carried out by the originally responsible members. When such teams faced with challenges, all members were knowledgeable on their own area of expertise, so the appropriate members stepped in to solve the

problem. However, when such a challenge prevented a member from fulfilling his/her roles, somebody else was ready to fill in for him/her thanks to the appropriate mechanisms established. In another example, many mid to high performing teams were able to formulate plausible plans and even contingency plans prior to the trading period. However, most of the time, the performance differences between these teams were determined by their ability to detect when it was necessary to deviate from the original plan and their courage to accomplish that deviation. As a final example, some teams practiced rigorously to overcome the errors and to maintain performance levels during other kinds of challenges. Some others went one step further; modelled the trading period with trials in order to anticipate external challenges and formed contingency plans and strategies accordingly. However, at certain times, what determined team resilience was an ability to address the challenges, which allowed combining this accumulated knowledge with improvised solutions that were generated in the heat of the moment. This ability to bring these paradoxical elements together was observed among the most resilient and best performing teams.

When examining the resilience literature, one can see that similar contradictions in the demonstration of resilience were also observed by certain previous studies. In the examination of Mann Gulch disaster, Weick (1993) suggested utilizing existing knowledge but equally leaning towards novel solutions would have saved the lives of the firefighters. Subsequently in the conceptualization of *mindfulness* he and his colleagues indicated that HROs' ability to simultaneously 'believe and doubt' their past experiences not only allow them to benefit from those experiences, but also encouraged them to improvise novel solutions quickly when past experiences were useless (Weick, Sutcliffe and Obstfeld, 2008, p. 97). They also touched upon other contradictory dynamics and skills that these organizations exhibit when faced with adversities. For instance, they stated how successful HROs necessitate centralization for the effective coordination of response but at the same time require decentralization for 'local containment and resolution of problems' (Weick, Sutcliffe and Obstfeld, 2008, p. 117). Moreover, Kendra and Watchendorf (2003b) also identified the vitality of inherently contradictory elements of resilience during their fieldwork in the aftermath of the 9/11 attacks. They highlighted centralization as well as decentralization, and improvisation as well as preparedness, as all paradoxically essential to provide for resilient responses (Kendra and Wachtendorf, 2003, p. 50). In another study, Tierney (2003, p. 6) mentioned the ability 'to deviate both from plans and past experiences when necessary'

as an important facilitator of resilience, which is another unresolved paradox for resilient responses; and related with that, Rijpma (1997, p. 18) pointed out the 'switch from one mode of decision-making to another' as a characteristic of HROs while dealing with unexpected situations. Among these, Hamel and Välikangas (2003) specifically used the word *paradox* and stress the need to 'embrace paradox' in order to provide for sustained resilience.

Therefore, moving from both the propositions of previous studies and the findings of the qualitative analysis, a recommendation for the future studies of resilience may be to examine the relationship between resilience and paradoxes experienced by teams and organizations. *Ambivalence* (as described in section 6.3.1.2) is considered a form of paradox and is included among the constructs used in the questionnaires in the continuation of parent project. Similar to this, other concepts measuring the management paradoxical elements could be used in quantitative analyses of resilience. As an alternative, qualitative studies may be designed to reveal the paradoxical process of teams and organizations and the effects of these processes on resilience.

7.5.2.3 Ultimate outcomes other than "performance"

In this study, the outcome of being resilient in non-extreme challenging settings was identified as satisfactory *performance*, in line with the justification made in section 2.5.2. Subsequently, in the research model, a positive relationship between resilience and performance was proposed; and in the methodological design, tools were included to measure team performance objectively. This relationship was validated in this study. However, for future studies, researchers are encouraged to investigate other possible outcomes of resilience. For instance, in the context of extreme conditions (for e.g. high-reliability organizing), since the negative outcomes of challenges are related with the survival of an entity, the outcome of resilience is identified as *reliability* (Weick, Sutcliffe and Obstfeld, 2008). In circumstances where human life is in danger, the outcome of resilience may be *safety* and *security* (Richardson, 1995; Seville, Van Opstal and Vargo, 2015). In the context of well-being and positive organizational scholarship the effect of resilience on happiness, commitment and satisfaction can be examined (Youssef and Luthans, 2007; West, Patera and Carsten, 2009). Therefore, depending on the research field, analysis level, sector or industry, and the ultimate needs, desires and purposes of the investigated entity, the outcomes of resilience may change. This is also effectively saying that resilience support various other outcomes.

Researchers who aim to investigate resilience, particularly with a holistic view, may first examine the circumstances of the entities they are analysing in order to determine their ultimate needs and desires they may obtain by increasing resilience. Once the ultimate outcome (or outcomes) are identified, the researcher can then determine methods to measure them. These can help a resilience study in two ways: first, these measurements may serve as proxies to represent the level of resilience, if the cause and effect theorization is well grounded; second, if the methods are well-established to directly measure resilience, then, using two measurements, the nature of the relationship between resilience and these outcomes may be demonstrated.

8 Conclusion

In their introduction to how the *resilience* concept explains "positive adjustment in challenging conditions" and incorporates insight from the previous studies to thoroughly conceptualize it, Sutcliffe and Vogus (2003, p. 95) stated that:

> *"Dynamics that create or retain resources (cognitive, emotional, relational, or structural) in a form sufficiently flexible, storable, convertible, and malleable, give rise to resilience and allow organizations, their units, and their members to avert maladaptive tendencies and positively cope with the unexpected."*

These words guided my study, as well as many other studies carried out after this work. My main purpose has been not only to discover and validate such *dynamics* that leads to resilience on their own, but also to establish a comprehensive framework of how these dynamics manifest and intermingle in constituting the antecedents of *resilience*. Adding on to this, I also investigated the outcome (or outcomes) of resilience in the form of satisfactory performance. The systematic literature review conducted by Linnenluecke (2017) spanning 1977 to 2014 demonstrates that such a comprehensive and widely accepted framework is still not established. She points out that the questions of "what makes some organizations more successful in dealing with, and responding to, the unfamiliar" (2017, p. 4) and "whether and how organizations can avoid threat-rigidity and 'activate' resilience in response to threat, and how resilience can successfully be built across individual, group and organizational levels of analysis" (2017, p. 9) still cannot not be answered in a way that satisfies the resilience community and its stakeholders.

In my study, I identified these as my research questions, and over three and a half years, I tried to conduct thorough research in order to answer them. With this aim, I conducted a detailed literature analysis to establish a working framework, then, I improved this framework and brought it into an operationalizable format with an exploratory study, and, tested with a simulation study (as part of a parent project on resilient teams) utilising both quantitative and qualitative research methods. Agreeing with Cumming *et al.*'s (2005, p. 976) statement: "If we define a priori the variables that lead to system resilience, then our conclusions will be largely driven by our initial

selection of variables", in the main analysis, I not only tested the relationships I identified by the literature review, but also observed additional relationships.

As mentioned previously, one of my objectives was to understand and validate the transferability of the principles applied in extreme organizational settings to demonstrate resilience into non-extreme organizational settings. Linnenluecke (2017, p. 11) indicates this as one of the several other unanswered questions of the resilience field. To achieve this objective, first of all, the main study simulations were designed to replicate a non-extreme but still challenging organizational setting. Moreover, the outcome of resilience was identified as *performance* rather than *reliability, safety* or *survival*, as this is identified as one of the elements that differentiate the organizations in extreme settings from the organizations in non-extreme challenging settings. The results suggest that resilience is very important in obtaining satisfactory performance levels, just as it is in providing for reliability and safety.

The final version of the model of collective resilience (as shown in section 7.2) aimed to serve the purposes of various stakeholders. Theoretically, I expected it to fill the gap of a comprehensive and widely accepted framework that explains resilience, of course, after further rigorous replications and validations. Since this study is conducted at the team level, it could first be tested at organizational level and since this study did not specify any sector or industry for its application, it could also be tested in specific sectors (and industries) to validate its applicability in a wide range of organizational settings. Furthermore, practically, I intend this framework to guide organizations and their collective units to apply the necessary principles to demonstrate resilience against the challenges and adversities they face. I provided recommendations for them (in section 7.4.2) with regards to which actions may be taken in permanent and temporary contexts, for operational and managerial tasks, when faced novel and non-novel challenges, and during operational and non-operational periods.

As a final word, investigating, understanding and achieving resilience is proved, in this study as well as in all other studies in this field, to be a difficult, long-lasting, complex, and constantly developing challenge. Over the three and a half years of this study, I carried out my work with the hope of contributing to this progress, but also with the acceptance of not pursuing a moving target. Hence, even before the beginning of this study, I expected to design further studies to continue this work, in progressing the

resilience field, and in helping teams and organizations to successfully overcome the challenges they face.

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10 Appendices

10.1 Various definitions of 'resilience'

Source	Level	Definition	Dimensions and Facilitators of Resilience
(Holling, 1973)	Ecological	"Resilience is a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables." (as opposed to stability)	Keeping options open Viewing events in a regional rather than a local context Emphasizing heterogeneity
(Meyer, 1982)	Organizational	"Resiliency occurs when responses create negative-feedback loops that absorb jolts' impacts and loosen couplings between organizations and their environments."	Strategic (Innovativeness, Attention to environment, Boundary spanning, Scope of general services, Outpatient and long-term scope, Medicare scope) Ideological variables (Importance of environment, Strategic reorientations, Benefits from changes, Subordinates' capabilities, Benefits from participation) Decentralization
(Wildavsky, 1988)	System	"Resilience is the capacity to cope with unanticipated dangers after they have become manifest, learning to bounce back." (as opposed to anticipation)	Resourcefulness Flexibility
(Weick, 1993)	Group	No definition given	Improvisation, Virtual role systems, The attitude of wisdom, Norms of respectful interaction
(Pulley, 1997)	Organizational	"Resilience is associated with elasticity, buoyancy, and adaptation. It is also associated with a strong life energy... A lack of resilience manifests as paralysis, depression,	Organizational learning Corporate mission (a larger purpose) Corporate culture (a binding identity)

		defensiveness and cynicism, Communication across functions or departments declines because job insecurity often causes increasing fortification around turf. Even in rapidly growing organizations, many people seem paralyzed around making decisions or taking action in the face of enormous ambiguity. Or if they do take action, they react habitually rather than creatively simply because there is not time to think. Consequently, organizations lose adaptability, and the result is lower productivity and declining performance. Organizations that lack resilience are out of synch with their environment."	Partnering and strategic alliances Staff elasticity (inclusion of temporary workers and outsourcing) Compensation tied to organizational performance.
(Horne and Orr, 1997)	Individual, group, organizational & systems	"Resilience is a fundamental quality of individuals, groups, organizations, and systems as a whole to respond productively to significant change that disrupts the expected pattern of events without engaging in an extended period of regressive behaviour."	Community (shared purpose within) Learning Standards Culture Work environment Competence (effective blended skills and knowledge) Connections (relationships within) Commitment Communications (flow of relevant information) Coordination (accurate linking of effort for effective results) Consideration (self-checking/correction for accountability and harmony)

(Horne, 1997)	Individual, group, organizational & systems	"Organizational resilience is the ability of a system to withstand the stresses of environmental/composition of the system pieces, their structural interlinkages, and the way environmental change is transmitted and spread throughout the entire system. To varying degrees, resilience is a fundamental quality found in individuals, groups, organizations, and systems as a whole. It allows positive response to significant change that disrupts the expected pattern of events without resulting in regressive/non-productive behaviour."	Communication Coordination Competencies Commitment Consideration Connections Community
(Mallak, 1998b)	Organizational & individual	"…design(ing) and implement(ing) positive adaptive behaviours quickly that are matched to the immediate situation – while enduring minimal stress all the while."	Perceiving experiences constructively Performing positive adaptive behaviours Ensuring adequate external resources Expanding decision-making boundaries Practicing bricolage Developing tolerance for uncertainty Building virtual role systems
(Mallak, 1998a)	Individual & organizational	"…the ability of an individual or organization to expeditiously design and implement positive adaptive behaviours matched to the immediate situation, while enduring minimal stress."	Goal-directed solution-seeking; Avoidance; Critical understanding; Role dependence; Source reliance; Resource access
(Mallak, 1999)	Individual & organizational	Adopted from author's previous study.	Vision Values

			Elasticity Empowerment Coping Connections
(Weick, Sutcliffe and Obstfeld, 2008)	Organizational	"Resilience is not only about bouncing back from errors, it is also about coping with surprises in the moment. It is important to retain both connotations of resilience to avoid the idea that resilience is simply the capability to absorb change and still persist. To be resilient also means to utilize the change that is absorbed."	Credibility Trust Attentiveness Ability to cope with surprises Ability to form epistemic networks Formal support for improvisation Ability to recombine actions from repertoire Ambivalence (having both hope and doubt)
(Reason, 2000)	Organizational	"A resilient system… has intrinsic 'safety health'; it is able to withstand its operational dangers and yet still achieve its objectives."	No characterization given
(Carpenter *et al.*, 2001)	Socioecological	"Resilience is the magnitude of disturbance that can be tolerated before a socioecological system (SES) moves to a different region of state space controlled by a different set of processes."	No characterization given
(Alesch *et al.*, 2001)	Organizational & system	"Resilience… (for people who are concerned with more complex, dynamic systems) is the ability of a system to recover from or adjust easily to misfortune or change… the ability to bounce back following a significant external shock."	Redundancy Financial strength Adaptability

(Coutu, 2002)	Individual	"…the skill and the capacity to be robust under conditions of enormous stress and change."	(1) Acceptance of reality, (2) A belief mechanism with strongly held values (the link between the value systems and the resilient organizations) and (3) Ability to improvise Sense of humour Ability to form attachment with other Possession of an inner psychological space that protects from abusive people Ability to attract people and make them help you Having an optimistic nature that do not distort your sense of reality
(Hamel and Valikangas, 2003)	Organizational	"(T)he ability to dynamically reinvent business models and strategies as circumstances change... a capacity for continuous reconstruction."	Aiming for "zero trauma" Conquering denial Valuing variety Liberating resources (as opposed to being conservative) Embracing the paradox (efficiency & resourcefulness)
(Sutcliffe and Vogus, 2003)	Individual, Team & Organizational	"… refers to the maintenance of positive adjustment under challenging conditions…Dynamics that create or retain resources (cognitive, emotional, relational, or structural) in a form sufficiently flexible, storable, convertible, and malleable, give rise to resilience and allow organizations, their units and their members to avert maladaptive tendencies and positively cope with the unexpected…resilience is the capacity to	Balancing the growth and competence (i.e. efficiency) Enhance variation Innovation Efficiency Honing existing competencies Enhancing competencies that provide mindfulness Utilizing ordinary processes Improvising

		rebound from adversity strengthened and more resourceful."	Recombining behavioural repertoires Restoring efficacy (structures that allow flexibility) Norms, structures, practices Conceptual slack Ad hoc problem-solving networks Utilizing media to communicate
(Kendra and Wachtendorf, 2003b)	Group & Organizational	"…socially constituted adaptability to unpredictable ambient forces."	Adaptive behaviour Improvisation Goal-directed solution seeking Incorporation resources from diverse sources
(Freeman, Hirschhorn and Triad, 2003a)	Organizational	"Resilience means the ability to spring back to original form from stress, illness or adversity."	Relationships Management of emotions Moral Purpose
(Fiksel, 2003)	System	Adopted from different studies	Diversity: existence of multiple forms and behavio(u)rs; Efficiency: performance with modest resource consumption; Adaptability: flexibility to change in response to new pressures; Cohesion: existence of unifying forces or linkages.
(Bruneau *et al.*, 2005)	Systems	"…the ability of social units, e.g., organizations and communities, to mitigate hazards, contain the effects of hazard-related disasters when they occur, and carry out recovery activities in ways that minimize social disruption and mitigate the effects of future hazards."	Robustness Redundancy Resourcefulness Rapidity

(Cumming *et al.*, 2005)	Systems	"the ability of the system to maintain its identity in the face of internal change and external shocks and disturbances" (2005, p. 976)	Components Relationships Innovation Continuity
(Lengnick-Hall and Beck, 2005)	Organizational	"Resilience capacity is defined as a unique blend of cognitive, behavioural, and contextual properties that increase a firm's ability to understand its current situation and to develop customized responses that reflect that understanding."	Cognitive resilience, Constructive Sensemaking A strong ideological identity Behavioural resilience, Complex and varied action inventory Functional habits Contextual resilience Deep social capital Broad resource network
(Sheffi, 2005)	Organizational	"For companies, it [resilience] measures their ability to, and speed at which they can, return to their normal performance level – production, services and fill rate – after a high impact/low probability disruption."	Redundancy: safety stock of material and finished goods Flexibility: developing ability to move in the face of a crisis
(McManus *et al.*, 2007)	Organizational	"Resilience is a function of an organization's overall situation awareness, management of keystone vulnerabilities, and adaptive capacity in a complex, dynamic, and interconnected environment."	Situation Awareness Roles and Responsibilities Understanding of Hazards and Consequences Connectivity Awareness Insurance Awareness Recovery Priorities Management of Keystone Vulnerabilities

			Planning Strategies Participation in Exercises Capability and Capacity of Internal Resources Capability and Capacity of External Resources Organisational Connectivity Adaptive Capacity Silo Mentality Communications and Relationships Strategic Vision and Outcome Expectancy Information and Knowledge Leadership, Management and Governance Structures
(McDaniels *et al.*, 2008)	Systems	Adopted from various resources	Robustness: the extent of system function that is maintained Rapidity: the time required to return to full system operations and productivity
(Ponomarov and Holcomb, 2009, p. 131)	Organizational	"The adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function"	Event readiness Effective Response Recovery
(Stephenson, 2010b)	Organizational	Adopted from various resources	Resilience Ethos Commitment to resilience Network perspective

	Situation Awareness Roles and Responsibilities Understanding of Hazards and Consequences Connectivity Awareness Insurance Awareness Recovery Priorities Internal and external situation monitoring and reporting Informed decision making Management of Keystone Vulnerabilities Planning Strategies Participation in Exercises Capability and Capacity of Internal Resources Capability and Capacity of External Resources Organisational Connectivity Robust processes for identifying and analysing vulnerabilities Staff engagement and involvement Adaptive Capacity Silo Mentality Communications and Relationships Strategic Vision and Outcome Expectancy Information and Knowledge

			Leadership, Management and Governance Structures Innovation and creativity Devolved and responsive decision making
(Lengnick-Hall, Beck and Lengnick-Hall, 2011)	Organizational	"Organizational resilience is defined here as a firm's ability to effectively absorb, develop situation-specific responses to, and ultimately engage in transformative activities to capitalize on disruptive surprises that potentially threaten organization survival"	Cognitive resilience, Constructive Sensemaking Strong core values coupled with a sense of purpose and identity Behavioural resilience, Learned resourcefulness, ingenuity, and bricolage A combination of useful habits and behavioural preparedness Contextual resilience Psychological Safety Deep social capital Diffuse power and accountability Broad resource network
(Carpenter *et al.*, 2012)	Socio-Ecological	"General resilience is the capacity of social-ecological systems to adapt or transform in response to unfamiliar, unexpected and extreme shocks."	Diversity, Modularity, Openness, Reserves, Feedbacks, Nestedness, Monitoring, Leadership, Trust

(Lee, Vargo and Seville, 2013)	Organizational	Adopted from: (McManus *et al.*, 2008)	Adaptive Capacity Minimization of silos Internal resources Staff engagement and involvement Information and knowledge Leadership Innovation and creativity Decision making Situation monitoring and reporting Planning Planning strategies Participation in exercises Proactive posture External resources Recovery priorities
(Linnenluecke, Griffiths and Winn, 2012)	Organizational	"…we define resilience as organizational capacity to absorb the impact and recover from the actual occurrence of an extreme weather event."	Impact resistance: the capacity of an organization to withstand a damaging impact as it occurs Rapidity: the capacity of an organization to quickly recover and to restore to a pre-disturbance or even an improved state after experiencing a damaging impact

Table 29. Various definitions of resilience

10.2 Exploratory study data collection guidelines

PRE-EXERCISE DISCUSSION	
Individual Level	**Team Level**
- Feelings right before the game - Confidence / Hope? Doubt / Hesitation? Ambivalence? - Expectations regarding the forthcoming experience: Positive or Negative perceptions? Or both? (What do you expect / think is going to happen?)	- Would you like to develop a strategy? (may show rigidity vs. flexibility and coordinated action vs. deviation from plan) - Does anyone have any suggestion regarding how you should approach to game?
THINGS TO WATCH FOR DURING SESSION	
Individual Level	**Team Level**
- Hope vs. doubt - confidence vs. hesitation - braveness vs. fear - positive vs. negative attitude - rigidity vs. flexibility - self-orientation vs. other orientation - competitive vs. collaborative - big picture vs. attention for detail	- diversity vs. unity - sophistication vs. simplicity - positive vs. negative attitude - existing capabilities vs. improvisation - specific role vs. filling in for other - rigidity vs. flexibility - interactive vs. detached - central vs. de-central - coordinated action vs. deviation from plan - Were there any constructive challenge & debate?
POST-EXECISE DISCUSSION	
Individual Level	**Team Level**
- Can you self-evaluate yourselves regarding your success / approach /…? - How would you evaluate your experience? Did you enjoy? Did you feel exited during the game? If not, what did not fulfil your expectations? - How were your feelings during and after the game?	- What were your strengths and weaknesses as a team? - How did you deal with obstacles and difficulties as a group? - What were the factors that impeded or facilitated problem-solving? - Were there any constructive challenge & debate? - How was the construction of a common frame of reference/ shared understanding? Do you think did you have it at all? Do you think you could keep it throughout the game? - Why did you fail? / What made you successful? - Why did your initial strategy fail? Why didn't you go with it in the first place? - What could you do better? What would you change in your attitudes / behaviours / choices / decisions if you were playing the game again? (if you again had some pre-time to develop a strategy)

10.3 Examples of documents provided with the Starter/Pre-Order Pack

10.3.1 General Product Specifications

Product and Delivery Specifications

All products will be inspected on delivery to ensure that they meet these specifications. Products that do not meet the specifications will be rejected by the inspectors.

1. Text inside and on the rear of the card to be legible and neatly handwritten in ink, using only the pens provided by the controllers. There should be no smudging.
2. All lines of text to be horizontal on the page, not drifting up or down.
3. The title of the occasion is to be stencilled on to the front cover and must be centred both horizontally and vertically. A5 cards must use 10mm stencils; a6 can use 5mm or 10mm, but must be consistent within the same order; A7 must use 5mm stencils.
4. Within the card, all text must fall within the following margins:

Size	Left	Right	Top	Bottom
A5	30mm	30mm	40mm	40mm
A6	20mm	20mm	30mm	30mm
A7	10mm	10mm	20mm	20mm

5. Verses should rhyme.
6. All cards in the same batch must have the same verse. Minor variations in handwriting are acceptable.
7. No pencil marks must be visible.
8. Closed folds must be at the top of A6 and A7 cards and on the front of A7 cards.
9. The manufacturer's identity and the sales order number must be written on the back of every card in the bottom right hand corner, next to the fold. The style "Co A/ SO1" must be used.
10. Products must be delivered to the inspectors in an A4 envelope, marked with the company's ID and the sales order number (e.g. "Co A/ SO1") on the white label.
11. Incomplete orders will be rejected.
12. Orders delivered late (or not at all) will incur a penalty charge of 20% of the value of the order.
13. Only equipment and materials bought from the controllers can be used in the Game, apart from calculators, laptops etc or certain other items by special permission. Companies found to be using illegal items during the Game will be fined.

10.3.2 Final Accounts Form

FINAL ACCOUNTS

Company ID:	

CASH AND ASSETS			£
Total value of cash			
Assets at end of game:	N		
Ruler		@ £ 300	
5 mm stencil		@ £ 400	
10mm stencil		@ £ 500	
Pen		@ £ 300	
Pencil		@ £ 100	
Rubber		@ £ 300	
Envelopes (each)		@ £ 10	
Sheets of white (per sheet)		@ £ 10	
Sheets of salmon (per sheet)		@ £ 20	
Sheets of pink (per sheet)		@ £ 20	
Sheets of blue (per sheet)		@ £ 20	
Sheets of green (per sheet)		@ £ 20	
Sheets of yellow (per sheet)		@ £ 20	
Total value of assets			
Valuation of assets at end of game (30% of purchase price)			
TOTAL VALUE OF CASH & ASSETS			

OUTGOINGS & LOANS

	£
Cost of table bought at auction	
Initial loan	
Interest on initial loan @ 10%	
1st emergency loan	
Interest on 1st emergency loan @ 25%	
2nd emergency loan	
Interest on 2rd emergency loan @ 25%	
3rd emergency loan	
Interest on 3rd emergency loan @ 25%	
Value of late / missed delivery penalties	
Fines	
Other	
TOTAL VALUE OF OUTGOINGS & LOANS	
PROFIT/LOSS AT END OF GAME	

10.3.3 Emergency Loan Application Form

EMERGENCY LOAN APPLICATION

To be submitted in person to the Game's Banker

Company	
Amount requested	
Time request submitted:	

Please tick which of the following applies:

This is our...	Interest Rate	
First emergency loan	25%	
Second emergency loan	25%	
Third emergency loan	25%	

Please state why the loan/s your Company previously requested are inadequate for your needs:

Please describe the precise steps your company will take to ensure that you will not require further emergency funding:

Decision: Approved Declined

By: _____

10.3.4 Procurement Form

PROCUREMENT REQUEST FORM (PRF)

Use this document to order equipment and materials over and above your initial starter pack. All purchases are cash on collection – if your company does not have the cash available, you cannot obtain any supplies.

All orders have a leadtime of 5 minutes between placing the order and the earliest time of collection. At periods of peak demand, it may take longer than 5 minutes to fulfil your procurement request.

Company Name (*please circle your Company ID*)

A B C D E F G H I
J K L M N O P Q

	N required	Cost per unit	Total cost
12" rulers		£300	
5 mm stencils		£400	
10 mm stencils		£500	
Pens		£300	
Pencils		£100	
Rubbers		£300	
Paper - white (per sheet)		£10	
Paper - salmon (per sheet)		£20	
Paper - pink (per sheet)		£20	
Paper - blue (per sheet)		£20	
Paper - green (per sheet)		£20	
Paper - yellow (per sheet)		£20	
Envelopes (each)		£10	
Total – equipment and materials			

Time order placed		**Collection time**	

Payment received by	

10.4 Example of a Sales Order and Delivery Notice (SODN)

SALES ORDER AND DELIVERY NOTICE

Sales Order Number:	1

Order details:

Occasion	N of cards	Colour	Size	Lines of verse	Leadtime (mins)	Market Price
Christmas	**4**	**White**	**A5**	**6**	**15**	**£150**

Company Name (*controllers to circle*)

A B C D E F G H I J K L M N O P Q

Time order granted		5 014016 150821
Time order due		
Controller signature		

Delivery (*controllers to circle*):

Was the order delivered on time? YES NO

Quality (*controllers to circle*)

Did the product meet the specifications? YES NO

Payment made to Company? YES NO

Comments:

Controller initials:_ ____

10.5 The latest version of pre- and post-trading questionnaires

10.5.1 Pre-trading questionnaire

MSc 2017-18: PRE-TRADING QUESTIONNAIRE

The purpose of this short survey is to provide baseline information about each company in the Production Game and the mood amongst its members ahead of the Game itself. This information will be put anonymously into a database and used to generate summary data on the features of each company and its performance that you can use, if you wish, in your analysis of the Game.

1. Your Company ID (A, B, C etc)	
2. Your student number*	

* Your student number will be used only for the purpose of matching your pre- and post-game questionnaires – no individuals will be identified or be identifiable in any report.

Please look at the following list of statements and think about how they apply to **your team**. Please indicate the extent to which you agree or disagree by *circling* the appropriate response.

		Strongly disagree				Strongly agree
3	My team knows how to cope with challenges	1	2	3	4	5
4	My team is able to cope with difficult periods of time	1	2	3	4	5
5	My team knows how to handle difficult situations when we face them	1	2	3	4	5
6	This team has confidence in itself	1	2	3	4	5
7	This team believes it can become unusually good at producing high-quality work	1	2	3	4	5
8	This team expects to be known as a high-performing team	1	2	3	4	5
9	This team feels it can solve any problem it encounters	1	2	3	4	5
10	This team believes it can be very productive	1	2	3	4	5
11	This team can get a lot done when it works hard	1	2	3	4	5
12	No task is too tough for this team	1	2	3	4	5
13	This team expects to have a lot of influence around here	1	2	3	4	5
14	We have a good "map" of each person's talents and skills	1	2	3	4	5
15	We have talked about mistakes and ways to learn from them	1	2	3	4	5
16	We have discussed our unique skills with each other so that we know who has relevant specialized skills and knowledge	1	2	3	4	5
17	We have discussed alternatives as to how to go about our activities	1	2	3	4	5
18	When discussing emerging problems, we usually discussed what to look out for	1	2	3	4	5
19	When attempting to resolve a problem, we have taken advantage of the unique skills of colleagues	1	2	3	4	5
20	We have spent time identifying activities we do not want to go wrong	1	2	3	4	5
21	When errors might happen, we have discussed how we can prevent them	1	2	3	4	5
22	When crises or problems occurred, we rapidly pooled our collective expertise to attempt to resolve them	1	2	3	4	5

1

We now have a few questions about how you think **you personally** deal with challenging situations. Please circle the responses that you feel best describe how you handle difficult circumstances.

		Strongly disagree				Strongly agree
23	I tend to bounce back quickly after hard times	1	2	3	4	5
24	I have a hard time making it through stressful events	1	2	3	4	5
25	It does not take me long to recover from a stressful event	1	2	3	4	5
26	It is hard for me to snap back when something bad happens	1	2	3	4	5
27	I usually come through difficult times with little trouble	1	2	3	4	5
28	I tend to take a long time to get over set-backs in my life	1	2	3	4	5

Items 29-32 removed

During your preparation for the Game, how often did you... ?

		Never				Always
33	Create new ideas for improvements	1	2	3	4	5
34	Search out new working methods, techniques, or instruments	1	2	3	4	5
35	Generate original solutions to problems	1	2	3	4	5
36	Mobilize support for innovative ideas	1	2	3	4	5
37	Acquire approval for innovative ideas	1	2	3	4	5
38	Make organizational members enthusiastic for innovative ideas	1	2	3	4	5
39	Transform innovative ideas into useful applications	1	2	3	4	5
40	Introduce innovative ideas into the environment in a systematic way	1	2	3	4	5
41	Evaluate the utility of innovative ideas	1	2	3	4	5

	Of the 15 companies in the MSc Production Game this year, in what position do you predict your company will rank? (1-15, where 1 = top)	

	Approximately how many hours in total do estimate that you have PERSONALLY spent on preparation for the Production Game?	

	Approximately how many hours has your team spent in meetings, practice sessions, etc for the Production Game (i.e. sessions at which ALL or MOST of team members have been present)?	

	Approximately how many years of full-time work experience do you have (ie excluding part-time or vacation jobs as a student)?	

Opt-Out Clause Your responses will be entered into a database containing information from multiple Production Games and used to provide information for you to use in your final report if you wish to do so. Information will be anonymous and presented only as team averages. The database will also be used for UEBS research into team effectiveness and resilience. Please tick here if you do **NOT** want the information you have provided to be used in this way.	

10.5.2 Post-trading questionnaire

MSc POST-TRADING QUESTIONNAIRE 2017-18

Your answers to this short survey will provide a view of the experiences of you and your fellow team members during the Production Game. This information will go anonymously into a database and will be used to generate summary data that you can use in your final individual report that analyses your team's performance.

1. Your Company ID (A, B, C etc)	

2. Your student number	

Your student number will be used only for the purpose of matching your pre- and post-trading questionnaires. No individual will be identified (or be identifiable) in any data released to the class.

3. Out of the **15** companies in the Game, in what position do you think your company will finish when the performance data are revealed? (i.e. 1st, 2nd, 3rd etc) ☐

4. [Q4 removed for 2017]

5. Please indicate how often you experienced each of the following states during the Game:

		Never				Always
5.1	Tense	1	2	3	4	5
5.2	Uneasy	1	2	3	4	5
5.3	Worried	1	2	3	4	5
5.4	Calm	1	2	3	4	5
5.5	Contented	1	2	3	4	5
5.6	Relaxed	1	2	3	4	5
5.7	Depressed	1	2	3	4	5
5.8	Gloomy	1	2	3	4	5
5.9	Miserable	1	2	3	4	5
5.10	Cheerful	1	2	3	4	5
5.11	Enthusiastic	1	2	3	4	5
5.12	Optimistic	1	2	3	4	5

6. During the Game, how often did you **personally** engage in each of the following activities:

		Never				Always	Not applicable
6.1	Creating new ideas for improvements	1	2	3	4	5	
6.2	Searching out new working methods, techniques, or instruments	1	2	3	4	5	
6.3	Generating original solutions to problems	1	2	3	4	5	
6.4	Mobilizing support for innovative ideas	1	2	3	4	5	
6.5	Acquiring approval for innovative ideas	1	2	3	4	5	
6.6	Making organizational members enthusiastic for innovative ideas	1	2	3	4	5	
6.7	Transforming innovative ideas into useful applications	1	2	3	4	5	
6.8	Introducing innovative ideas into the work environment in a systematic way	1	2	3	4	5	
6.9	Evaluating the utility of innovative ideas	1	2	3	4	5	

1

7. Please consider the following statements and think about how they applied to your team during the Game.

		Strongly Disagree				Strongly agree
7.1	My team knew how to cope with challenges	1	2	3	4	5
7.2	My team was able to cope with difficult periods of time	1	2	3	4	5
7.3	We (team members) knew how to handle difficult situations when we faced them	1	2	3	4	5
7.4	We had a good "map" of each person's talents and skills	1	2	3	4	5
7.5	We talked about mistakes and ways to learn from them	1	2	3	4	5
7.6	We discussed our unique skills with each other so that we knew who has relevant specialized skills and knowledge	1	2	3	4	5
7.7	We discussed alternatives as to how to go about our normal work activities	1	2	3	4	5
7.8	When discussing emerging problems with co-workers, we usually discussed what to look out for	1	2	3	4	5
7.9	When attempting to resolve a problem, we took advantage of the unique skills of our colleagues	1	2	3	4	5
7.10	We spent time identifying activities we did not want to go wrong.	1	2	3	4	5
7.11	When errors happened, we discussed how we could have prevented them	1	2	3	4	5
7.12	When a crisis occurred, we rapidly pooled our collective expertise to attempt to resolve it	1	2	3	4	5
7.13	Each team member had specialized knowledge of aspects of our project	1	2	3	4	5
7.14	I had knowledge about an aspect of the project that no other team member had	1	2	3	4	5
7.15	Different team members were responsible for expertise in different areas	1	2	3	4	5
7.16	The specialized knowledge of several different team members was needed to complete the project deliverables	1	2	3	4	5
7.17	I knew which team members had expertise in specific areas	1	2	3	4	5
7.18	I was comfortable accepting procedural suggestions from other team members	1	2	3	4	5
7.19	I trusted that other members' knowledge about the project was credible	1	2	3	4	5
7.20	I was confident relying on the information that other team members brought to the discussion	1	2	3	4	5
7.21	When other members gave information, I wanted to double-check it for myself R	1	2	3	4	5
7.22	I did not have much faith in other members' "expertise" R	1	2	3	4	5
7.23	Our team worked together in a well-coordinated fashion	1	2	3	4	5
7.24	Our team had very few misunderstandings about what to do	1	2	3	4	5
7.25	Our team needed to backtrack and start over a lot R	1	2	3	4	5
7.26	We accomplished the task smoothly and efficiently	1	2	3	4	5
7.27	There was much confusion about how we would accomplish the task (R)	1	2	3	4	5

8. Please indicate how **cohesive** you considered your group to be:

		Strongly Disagree				Strongly agree
8.1	Team members were united in trying to reach our goals for performance	1	2	3	4	5
8.2	All team members shared task responsibility for any mistake	1	2	3	4	5
8.3	Everyone tried to help if members had problems	1	2	3	4	5
8.4	Team members communicated freely about each other's responsibilities	1	2	3	4	5
8.5	Members rather went out on their own than as a team	1	2	3	4	5
8.6	Team members rarely socialized together	1	2	3	4	5
8.7	We liked to spend time outside of work hours	1	2	3	4	5
8.8	We stick together outside of the team project	1	2	3	4	5

9. Please indicate how effective your team was at **improvising** as required during the game:

		Strongly Disagree				Strongly agree
9.1	The team dealt with unanticipated events on the spot	1	2	3	4	5
9.2	Team members thought on their feet when carrying out actions	1	2	3	4	5
9.3	The team responded in the moment to unexpected problems	1	2	3	4	5
9.4	The team tried new approaches to problems	1	2	3	4	5
9.5	The team identified opportunities for new work processes	1	2	3	4	5
9.6	The team took risks in terms of producing new ideas in doing its job	1	2	3	4	5
9.7	The team demonstrated originality in its work	1	2	3	4	5

10. Please rate your team on the following features:

		Strongly Disagree				Strongly agree
10.1	There were times when I felt my team "lost it" during the Game	1	2	3	4	5
10.2	We developed cooperative arrangements with other teams	1	2	3	4	5
10.3	Cooperation with other teams was important to our performance	1	2	3	4	5
10.4	There was friction amongst members of our team	1	2	3	4	5
10.5	There were differences of opinions in our team	1	2	3	4	5
10.6	We were able to improvise effectively as the Game progressed	1	2	3	4	5
10.7	We actively sought information and tested what we could do	1	2	3	4	5
10.8	We had a strong team identity and a strong sense of common purpose	1	2	3	4	5

11. Did your Company experience any **crises** during the Game? YES NO

12. If so, please indicate the extent to which you felt that:

		Strongly Disagree				Strongly agree
12.1	The crisis was threatening to the performance of your team	1	2	3	4	5
12.2	There was very little time to respond to the crisis	1	2	3	4	5
12.3	The crisis was a real surprise to the team	1	2	3	4	5

13. Finally, please indicate the extent to which the following activities applied to your team:

		Strongly Disagree				Strongly agree
13.1	We had a well-developed "Plan B" in case things did not work out as we expected	1	2	3	4	5
13.2	Actual trading conditions were quite different to what we had expected	1	2	3	4	5
13.3	We constantly tested the limits of what we could and could not do, and what was and was not allowed	1	2	3	4	5
13.4	We were aware that there was a trade-off between the value of orders and the risk of not being able to fulfil them	1	2	3	4	5
13.5	As a team, we never really knew what we were capable of	1	2	3	4	5
13.6	We knew we might have to make decisions quickly during the Game and worked out a way to do it	1	2	3	4	5
13.7	We allowed members to accomplish tasks in different ways	1	2	3	4	5
13.8	We accepted reasonable risks	1	2	3	4	5
13.9	We did not blame other members when they made mistakes	1	2	3	4	5
13.10	We developed routines and processes before the Game	1	2	3	4	5
13.11	We adhered to the rules, routines and processes we had set	1	2	3	4	5
13.12	We stuck to our plan	1	2	3	4	5

Opt-Out Clause	
Your responses will be entered into a database containing information from multiple Production Games and used to provide information for you to use in your final report if you wish to do so. Information will be anonymous and presented only as team averages. The database will also be used for research into team resilience. Please tick here if you do **NOT** want the information you have provided to be used in this way.	

10.6 Contents of the self-completion measures

Team Resilience	• My team knew how to cope with challenges • My team was able to cope with difficult periods of time • We (team members) knew how to handle difficult situations when we faced them
Collective mindfulness	• We had a good "map" of each person's talents and skills • We talked about mistakes and ways to learn from them • We discussed our unique skills with each other so that we knew who has relevant specialized skills and knowledge • We discussed alternatives as to how to go about our normal work activities • When discussing emerging problems with co-workers, we usually discussed what to look out for • When attempting to resolve a problem, we took advantage of the unique skills of our colleagues • We spent time identifying activities we did not want to go wrong. • When errors happened, we discussed how we could have prevented them • When a crisis occurred, we rapidly pooled our collective expertise to attempt to resolve it
Transactive memory systems	• Each team member had specialized knowledge of aspects of our project • I had knowledge about an aspect of the project that no other team member had • Different team members were responsible for expertise in different areas • The specialized knowledge of several different team members was needed to complete the project deliverables • I knew which team members had expertise in specific areas • I was comfortable accepting procedural suggestions from other team members • I trusted that other members' knowledge about the project was credible • I was confident relying on the information that other team members brought to the discussion • When other members gave information, I wanted to double-check it for myself • I did not have much faith in other members' "expertise" • Our team worked together in a well-coordinated fashion • Our team had very few misunderstandings about what to do • Our team needed to backtrack and start over a lot • We accomplished the task smoothly and efficiently • There was much confusion about how we would accomplish the task
Team cohesion	• Team members were united in trying to reach our goals for performance • All team members shared task responsibility for any mistake • Everyone tried to help if members had problems

	• Team members communicated freely about each other's responsibilities • Members rather went out on their own than as a team • Team members rarely socialized together • We liked to spend time outside of work hours • We stick together outside of the team project
Collective improvisation	• The team dealt with unanticipated events on the spot • Team members thought on their feet when carrying out actions • The team responded in the moment to unexpected problems • The team tried new approaches to problems • The team identified opportunities for new work processes • The team took risks in terms of producing new ideas in doing its job • The team demonstrated originality in its work
Team Potency	• This team has confidence in itself • This team believes it can become unusually good at producing high-quality work • This team expects to be known as a high-performing team • This team feels it can solve any problem it encounters • This team believes it can be very productive • This team can get a lot done when it works hard • No task is too tough for this team • This team expects to have a lot of influence around here
Individual Resilience	• I tend to bounce back quickly after hard times • I have a hard time making it through stressful events • It does not take me long to recover from a stressful event • It is hard for me to snap back when something bad happens • I usually come through difficult times with little trouble • I tend to take a long time to get over set-backs in my life
Affective well-being	Please indicate how often you experienced each of the following states during the Game: • Tense • Uneasy • Worried • Calm • Contented • Relaxed • Depressed • Gloomy • Miserable • Cheerful • Enthusiastic • Optimistic

10.7 Performance data used in the calculation of performance indicators

Measure	Explanation	Contribution
Number of members	Throughout all seven runs of the simulation team sizes changed between 6 and 10. This number is recorded under this measure for each team.	It is used to calculate certain performance variables on the "per head" level as team sizes differed. It is also used as a control variable in the main analyses.
Number of successful orders	This is the number of the orders delivered by the team and accepted by the controllers as a result of which team got paid.	It is used to calculate rejection and unfulfillment percentages.
Cash at end	This is the value of the cash left at a team's account at the end of the trading period.	It is used to calculate the profit (loss).
Assets at end	This is the cash value of the materials (sheets and envelopes) and equipment (pen, stencils, rulers, etc.) returned by a team to the controllers in good and reusable condition (for e.g. unfolded and unwritten sheets). 70% of its initial value is considered depreciated and the remaining 30% is added to team's profit.	This value is used to calculate the profit (loss).
Total incomings	This is the total value of a team's cash and assets at the end of the trading period	This value is used to calculate the profit (loss).
Started pack	This is a pre-defined pack of materials and equipment provided to teams in the first four runs of the simulation (the amount is credited from their accounts), in addition to any pre-orders they make. In the last three runs of the simulation, this pack is not provided and teams decided the whole amount of their pre-ordered materials and equipment freely.	This value is used to calculate the profit (loss) for the first four runs of the simulation.
Loans and interests	This is the value of the materials, equipment and cash pre-ordered before the trading period plus any emergency loans taken during the trading period plus the interest incurred (10% for the pre-orders and 25% for the loans taken during the trading period).	This value is used to calculate the profit (loss).
Cost of table	Starting with the 3rd simulation, teams are offered to choose the position of their production table by paying for it. Auctions	This value is used to calculate the profit (loss).

	were organised, and positions were sold one by one to the teams which paid to highest amount. The amount is considered a pre-order loan and incurred 10% interest.	
Fines	Teams are fined if they do not oblige the rules of the simulation, for instance in the form of bringing equipment and materials apart from the ones provided by the controllers.	This value is used to calculate the profit (loss).
Delivery penalties	If a team cannot deliver an order within the order deadline, then this order is considered unfulfilled and incurred a penalty of the 20% of the order. This order is not considered for assessment and so, the team did not get paid even if the order would meet the specifications.	This value is used to calculate the profit (loss).
Total outgoings	This is the total value of starter pack (for the first four runs of the simulation), loans and interests, cost of table (for the last five runs of the simulation), fines and delivery penalties.	This value is used to calculate the profit (loss).

Table 30. Intermediary performance measures

10.8 An example template for Strategic Plans

2015-16 MBA Production Game: Review of Strategic Plans

In the week beginning 12 October 2015 each team should present a short strategic plan that spells out your aspirations and intentions for the Game. Please submit these to Nick by email (nick.oliver@ed.ac.uk) no later than 0900 on Wednesday 14 October. Review meetings should take place on the afternoons of Wednesday, Thursday or Friday 14-16 October. A representative from each team should contact Nick to arrange a time for their review meeting.

The strategic plan should be no more than three pages, and should address the following issues:

Company Mission

In no more than one sentence, summarize the purpose of your Company - what it stands for, who it serves and any sources of distinctiveness.

Objectives

List up to four main objectives for your Company.

Strategy

How will you ensure that your Company is competitive relative to the other companies in the marketplace? What do you see as your strengths? What are your weaknesses?

Organisation

Briefly describe how your organisation reflects your strategy.

Preparation & Planning

a) How many times has your team met to plan and prepare for the trading period?

b) What has been the typical duration of these meetings?

c) What has been the typical % attendance at these meetings?

Risks

What are the greatest sources of risk and uncertainty that your Company faces? What steps have you taken to mitigate these?

Finances

a) How much loan capital do you wish to apply for? (You should provide a brief rationale for the amount requested).

b) Approximately how much value do you think your Company will create during the Game? Please provide a ball park figure, in £, and a brief explanation of this.

Additional Information

Any extra information, not mentioned above, that you wish to provide.

10.9 Strategic review meeting guidelines for the researchers

- Explain the purpose of your company and how you plan to ensure you will fulfil it.
- How did you design your organisation that will support your strategy?
    - How will you approach the task?
        - Have you decided on any particular strategy concerning how you will select your orders (e.g., are you planning to go for a particular type of orders?)
    - How have you divided the work/ how did you decide who will take on specific roles?
    - What roles are your team members expected to take on?
    - Have you designated a leader of your company? If yes, has that facilitated or perhaps impaired your planning and preparations for the game?
    - How will you coordinate your activities?
- What are the greatest risks that your Company faces? Describe any steps you have taken to mitigate these risks.
- How much loan do you request and why? What is your rationale behind this amount?

Preparation & Planning

a) How many times has your team met to plan and prepare your strategic plan?
b) How many times has your team met to plan and prepare for the trading period?
c) What has been the typical duration of these meetings (in minutes)?
d) What has been the typical % attendance at these meetings?
e) On a scale from 1 (no effort at all) to 5 (a lot of effort), how much effort have you put into preparation for the trading period?
f) On a scale from 1 (very poor) to 5 (excellent), how would you rate the cooperation between team members during the preparation period?
g) On a scale from 1 (not at all frequent) to 5 (very frequent), how frequently have you experienced conflicts during the preparation period?
h) On a scale from 1 (not at all disruptive) to 5 (very disruptive), how disruptive have the conflicts you experienced been during the preparation period?

If you purchased the table in the auction, what were the reasons for going to that particular table?